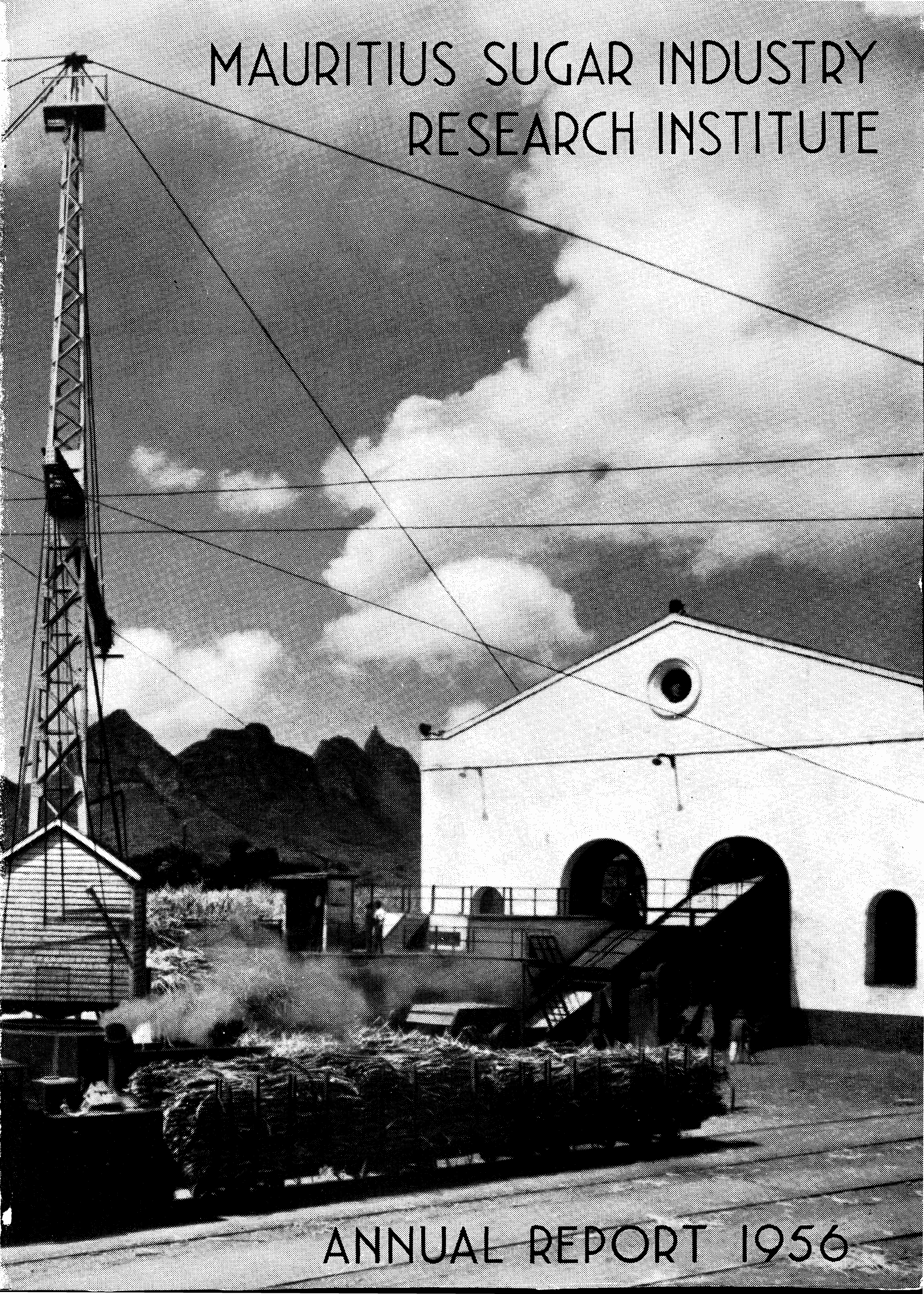
MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE



ANNUAL REPORT 1956

Mauritius Sugar Industry Research Institute

ANNUAL REPORT 1956

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CORRIGENDA

ANNUAL REPORT, 1956

Page 27, table 5, *read* B. 34104 *instead of* B. 34004

" 44, " 14, *read* $Si\ 0_2/Al_2\ 0_3$ *instead of* $Si\ 0_2/R_2\ 0_3$

" 48, " 16, last line N.P.K. *read* K_2O % d.m. 1.12 *instead of* 1.27

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The photograph on the cover shows Mon Désert sugar factory, with the Moka mountain range in the background (Photo. Ph. Halbwachs).

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and the senior staff of the Research Institute.

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Mr. A. Moutia, Associate Entomologist, Department of Agriculture.

STAFF LIST

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"	R. Béchet, Dip.Agr. (Maur.)
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	Miss L. Kingdon

REPORT OF THE CHAIRMAN
EXECUTIVE BOARD, 1956

IN implementation of the accepted policy of infusing new blood every year into the Executive Board of the Institute, while maintaining thereon a core of members with first hand knowledge of its past work, the following changes in membership took place: Mr. Ph. de Labauve d'Arifat replaced Mr. C. Noël as representative of factory owners, Mr. R. Ducler des Rauches replaced Mr. A. Rouillard as representative of large planters (later replaced by Mr. George Rouillard when on overseas leave) and Mr. M. Kisnah replaced Mr. M. Ramdin as representative of small planters. The Board, thus reconstituted, held 18 meetings most of them at Headquarters at Réduit, while some, however, were held at Pamplemousses, Belle Rive and Union Park, on the occasion of the Board's visit to these stations. There was no change of policy and satisfactory progress continued on the lines laid down initially.

ESTABLISHMENT

There were two resignations during the year: Mr. S. North Coombes, Field Officer, and Mr. P. Rouillard, Laboratory Assistant, having accepted employment with two sugar Companies. Two new appointments, those of Mr. R. Béchet and Mr. C. Mongelard, filled these gaps. In addition, the vacant posts of Geneticist and Assistant Sugar Technologist were filled by the appointment of Mr. E. F. George, B. Sc., A.R.C.S., and Mr. J. P. Lamusse, B. S., respectively, who will start working for the Institute next year. Mr. M. M. d'Unienville was appointed Assistant-Secretary and Mr. L. de Réland, draughtsman-photographer, a new post added this year to the establishment. Mr. S. M. Feillafé was promoted to the post of Senior Assistant Chemist. During the Director's absence abroad on leave, Mr. A. de Sornay, Plant Breeder, acted as Director.

Apart from the Director who had useful contacts in England, France and Holland during his absence between February and September, members of the staff made visits overseas as under:

Messrs. E. Rochecouste, J. Dupont de R. de St. Antoine and G. Mazery formed part of the Mauritius delegation to the 9th Congress of the International Society of Sugarcane Technologists held in India in January.

Mr. R. Antoine visited Madagascar to follow the progress of the work there in connection with the control of Fiji disease.

Messrs. D. H. Parish and S. M. Feillafé spent two weeks in Madagascar under the auspices of the "Comité de Collaboration Agricole Maurice-Réunion-Madagascar" mainly in connection with soil studies.

Mr. P. Halais, while on overseas leave, attended the sixth International Soil Congress in Paris in August.

Mr. G. Rouillard went to Madagascar as a guest of the "Comité de Collaboration Agricole Maurice-Réunion-Madagascar".

The Director also attended the session of the "Comité de Collaboration" on his way back from Kenya where he had been requested by the Department of Agriculture to advise on the possible development of sugarcane cultivation in certain areas.

The Board's policy of maintaining overseas contacts was thus fully and usefully implemented.

DEVELOPMENT

The workshop and stores whose construction had been approved the previous year were duly completed at Réduit, while another house belonging to the Government was acquired by the Institute, thus adding to the accommodation available for its officers at Headquaters. The stations at Belle Rive, Pamplemousses and Union Park were further developed and, late in the year, arrangements were made to lease further plots of land adjoining the two latter stations to allow for their necessary extension.

The Board has also decided to extend the existing 'Arcon' building at Réduit to allow of more adequate accommodation for the Chemistry and Technology divisions.

As to the Government Bacteriological Laboratory, promised now four years ago to the Institute to house its main services, the only step forward is that delivery has now been promised for a definite date, viz: 1st August 1957. One can but hope that next year's report will record its handing over.

FINANCE

During the third financial year of the Institute, revenue has exceeded current expenditure by Rs. 205,761 66. This has brought the accumulated funds at 30th June 1956 to Rs. 676,346.18, and has allowed the Board to continue the heavy programme of capital expenditure which had been instituted for the development of laboratories and experimental stations. Adequate depreciation on all assets was provided and the various reserves were maintained at approximately the same level.

In view of the further delay in handing over the Bacteriological Laboratory, the Board arranged with the Anglo-Mauritius Assurance Society that the last instalment of Rs. 200,000 of its loan to the Institute be deferred to June 1957.

The revenue and expenditure account and balance sheet of the Institute appear on page 7 of this report.

This summary of the administrative and financial position should suffice as a preface to the report proper. I would merely record again my colleagues' and my own grateful appreciation of the work done by all and of the spirit of goodwill and devotion with which it has been done.

CHAIRMAN.

29th December 1956

REVENUE & EXPENDITURE ACCOUNT

Year ended 30th June 1956

RUNNING COSTS, MAINTENANCE & DEVELOPMENT OF STATIONS & LABORATORIES	391,004.64	CESS ON SUGAR EXPORTED ...	1,110,100.75
PERSONAL EMOLUMENTS & PENSION FUNDS CONTRIBUTIONS ...	354,611.76	MISCELLANEOUS RECEIPTS ...	41,016.65
FEES — BOARD MEMBERS, AUDITORS & LEGAL ADVISER	4,875.—		
GENERAL OFFICE & LIBRARY EXPENSES & PUBLICATION ...	68,783.94		
INTEREST ON LOAN	25,000.—		
TRANSFER TO RESERVE FUNDS — LEAVE & MISSIONS	50,000.—		
PHYTALUS CESS	51,080.40		
	945,355.74		
Excess of revenue over expenditure carried to accumulated funds	205,761.66		
Rs.	1,151,117.40	Rs.	1,151,117.40

BALANCE SHEET

as at 30th June 1956

ACCUMULATED FUNDS	676,346.18	FIXED ASSETS (at cost less depreciation & amounts written off)		
RESERVE FUNDS	53,034.89	Land & Buildings	717,370.95	
LOAN FROM A.M.A.S. LTD. ...	500,000.—	Equipment & Furniture — Laboratories, houses & offices	63,194.40	
INTEREST DUE ON LOAN	2,083.33	Agricultural Machinery & Vehicles	17,350.—	
				797,915.35
		CURRENT ASSETS		
		Sundry Debtors ...	24,613.88	
		Cash on Deposit ...	125,000.—	
		Cash at bank and on hand	283,935.17	
				433,549.05
Rs.	1,231,464.40	Rs.		1.231,464.40

AUDITORS' REPORT

We have examined the Books and Accounts of the Institute for the year ended 30th June, 1956, and have obtained all the information and explanations we have required.

In our opinion, proper books of account 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 30th June 1956, 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) A. L. NAIRAC
(sd) P. G. A. ANTHONY } *Board Members*

(sd) A. de SORNAY *Ag. Director*

Port-Louis,
Mauritius,
1st August. 1956.

(sd) P. R. C. du Mée
A.C.A. (S.A.), A.S.A.A.
p. p. de Chazal, du Méc & Co.
Chartered Accountants.

INTRODUCTION

IN his report for 1956, the Chairman of the Executive Board has reviewed briefly the development of the Sugar Industry Research Institute during the year. The Sugar Technology division was opened in January and later in the year a qualified Sugar Technologist was appointed to assist the head of this division. It was also decided that an Entomologist should be appointed at an early date; this decision was made possible by the kind co-operation of the Director of Agriculture who has offered laboratory space in his Department until the Medical Department buildings purchased from Government are handed over to the Institute. In this connection it is gratifying to record that a definite date (August 1957) has been set by Government to vacate these buildings. The Cane Breeding section was strengthened by the appointment of a Geneticist, who is at present doing post graduate studies at the Plant Breeding Institute, Cambridge, and will assume duty about August 1957. A Draughtsman-Photographer was appointed for specific work in connection with the soil survey of the Island and general duties in other divisions. The establishment of the Institute is thus nearing the original goal set at its inception in 1953.

Much of the equipment needed in the different laboratories was obtained during the year. The Chemistry and Sugar Technology divisions were equipped with a constant temperature room 9 x 16 ft running at 20°C + 0.3° which is being used for chromatography and for accurate analytical work demanding close control of temperature such as polarization studies.

Amongst the new equipment received was a Beckman D. U. spectrophotometer with a spectral energy recording adapter attachment and a strip chart recorder, which is working satisfactorily and is being used for absorption and chromatographic work. The Beckman D.U. spectrophotometer with flame photometer attachment, loaned by the Department of Agriculture for soil survey work, has proved invaluable for routine analytical determinations of potassium and sodium.

An automatic fraction collector with both drop-counting and timer mechanisms was also received and this instrument is being used for column-chromatography of the fatty and amino acids of cane juice.

The installation of a hot water tank ordered in 1955 was completed in June and is working satisfactorily; over 125 tons of cane were heat treated for experimental purposes and for establishing nurseries on plantations in various parts of the island.

Immediately after the end of the crop season, the Arcon building, which houses the heat treatment plant and cane analysis laboratory, was enlarged so as to provide more space. This new extension will also accommodate a soils laboratory.

In order to assess more accurately the effect of wind on the sugar crop, two Dines anemometers were ordered and will be installed in the eastern and western sectors, where no wind speed records have been available so far. Although this equipment will remain the property of the Institute, the Government Observatory Department has kindly agreed to undertake the operation and maintenance of the anemometers.

Development of the experiment stations progressed satisfactorily; new lands were brought under cultivation at Belle Rive, and arrangements were made with the owners of Rose Belle and Mon Rocher estates to extend the area available at Union Park and Pamplemousses Experiment Stations.

Concerning field experimentation, there were 133 trials (excluding selection trials) at the four stations of the Institute and on private lands in representative cane sectors of the Island. These were distributed between the various divisions of the Institute as follows: Plant Breeding, 48; Chemistry, 27; Agronomy, 28; Pathology, 18; Botany, 12.

The layout of this report follows the same pattern adopted in previous years, with a brief review of the work of the Institute in 1956, followed by more detailed information on specific subjects and the discussion of experimental results when possible. Statistical tables have been extended this year to include factory data.

2. THE 1956 SUGAR CROP

Sugar production in 1956 reached yet another record. 571,893 tons of sugar were produced from 168,717 arpents harvested, with average cane yields of 26.0 tons per arpent and 12.94% extraction (7.73 tons of cane per ton of sugar*). Yield of commercial sugar per arpent thus averaged 3.39 tons, the highest figure obtained in the history of the local sugar industry.

Reference to tables VII and VIII of the appendix demonstrates that weather conditions were excellent during the growing season, with adequate and well distributed rainfall. The sums of monthly deficits stood at 8.6 inches at the end of June instead of 15.0 inches which is a 75 year average. No cyclone passed within the danger zone. As a consequence, it was estimated in early July, according to Halais' equation published in the 1954 Annual Report, that the standing weight of cane was approximately 4,470,000 metric tons. Actually 4,421,000 metric tons were reaped for processing of which nearly 83% were grown from ratoon cane. Yields of plant cane and ratoons compared with the average are shown in fig. 1. From July to October, rainfall was about 50% below normal for each of the four months of the maturing period; thus favourable conditions prevailed for a high sucrose content. Grinding began with an average sucrose % cane higher by nearly one unit than the previous ten year

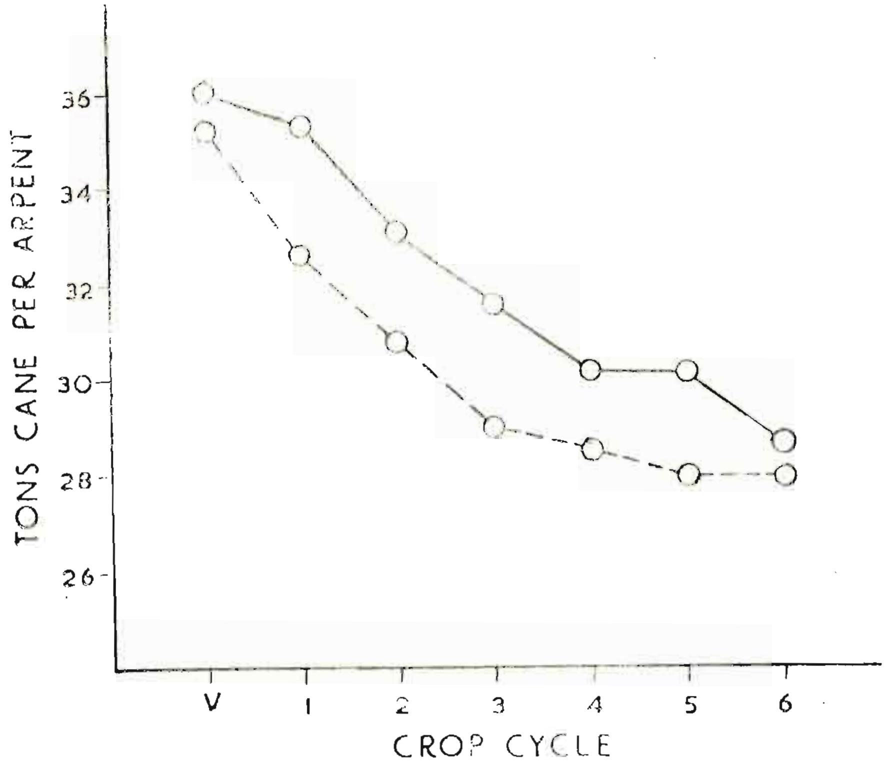

Fig. 1. Yield of virgin and ratoon canes on estates. Plain line, 1956 crop; broken line average 1947 -- 1955.

* Corrigendum, Ann. Rep. M.S.I.R.I. 1955, p. 9 *read* 7.93 *instead* of 7.50 tons of sugar.

average (fig. 2). In October, however, juice purity began to decline, affecting adversely commercial sugar manufactured % cane. Nevertheless the figure of 12.94 obtained for the Island as a whole is well above the average which is 12.15%. The highest figure obtained was in the north, where two factories averaged 14.39% extraction. It is important to

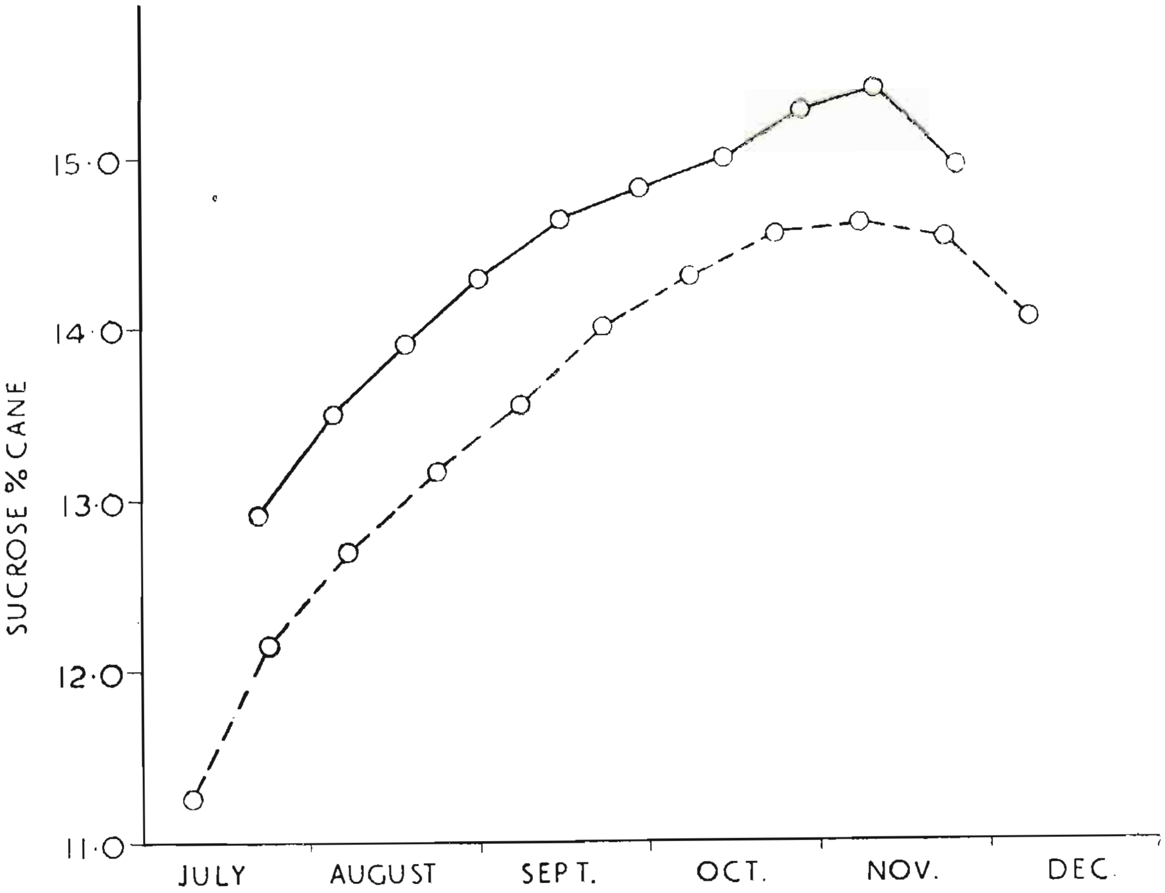

Fig. 2. Fortnightly variations in sucrose % cane. Plain line, 1956 crop; broken line, average 1947 -- 1955.

point out that the favourable growing and maturing conditions which prevailed have had a dominating influence on sugar production of the Colony in 1956. In this connection it is useful to survey briefly the salient features of the last ten sugar crops in Mauritius. These are recorded graphically in fig. 5 (page 19) from which it may be seen that the cultivated area has passed from 142,000 arpents in 1947 to 180,000 in 1956, an increase of 38,000 arpents equivalent to nearly 130,000 tons of sugar with the yields obtained in 1956. Yields of cane have fluctuated during the same period from 21.4 tons to 27.6 tons per arpent, while commercial sugar manufactured % cane, has been as low as 11.03% in 1953 to reach a maximum figure of 12.94% in 1956. The negative correlation existing between these two sets of data is striking: one curve being the "mirror image" of the other and both being primarily conditioned by the amount of rain received during the growing and maturing periods.

Although the influence of climatic conditions is of prime importance in local sugar production, other causes account for the steady increase of cane and sugar yields in recent years. Special mention should be made of varieties better adapted to the super-humid zone such as Ebène 1/37 and B. 3337; more efficient sugar factories of greater daily capacity; better flow of canes from field to factory; improvement of cultivation in its widest sense from land preparation with more adequate machinery to rational fertilization and the planting of disease-free cuttings over large areas. It is important to note that improvements in cultivation and varieties have enabled cane growers to increase the number of ratoons and obtain reasonable yields from lands which would not otherwise have produced an economic return.

3. THE CANE VARIETY POSITION

The schedule of approved varieties was increased in 1956 by the addition of three local canes: M. 147/44, M. 31/45, white M. 134/32 (a sport of M. 134/32) and a Bardados variety: B. 34104. Thus, excluding a number of old varieties maintained on the official schedule until 1963, (Proc. No. 5 of 1956) there are ten commercial varieties recommended for planting at present: M. 134/32, M. 112/34, Ebène 1/37, B. 3337, B. 37161, B. 37172 in addition to the four varieties listed above.

The area planted under different varieties on estates in 1956 (table IX of appendix) is illustrated graphically in fig. 3, which should be compared with the analogous figures published in 1954 and 1955, whereby the ever changing pattern of varieties can be accurately assessed. The steady decline of M. 134/32 cannot be recorded without a word of praise for this variety, which has played a major role in the sugar production of the Island during the last 15 years. It is firmly believed however that M. 134/32 will remain an important commercial cane, during many years to come in the sub-humid and humid lowlands where it still grows remarkably well. Results obtained so far in pre-release variety trials have given no indication that the white and striped sports of M. 134/32 are superior to the parent variety. It is possible however that the clone being younger, it has had less time to become infected with ratoon stunting virus, and therefore may produce better yields on a commercial scale.

Ebène 1/37 is still the most popular variety on the central plateau, and the higher regions of the eastern and southern sectors, where it grows and matures at its best. For the third year in succession, Ebène 1/37 accounted for approximately 30% of new plantings made on estates.

About a quarter of the area planted in 1956 was devoted to the four Barbados varieties B. 3337, B. 34104, B. 37161 and B. 37172.

The cultivation of B. 3337 should be restricted to regions of high rainfall where other canes are not suitable. It may be said that B. 3337 grows better on inferior lands of the super-humid zone than any other variety cultivated in the past. It has the serious drawback of having a high fibre content which accounts for a reduction of from 20% to 25 % in the crushing rate at the factory. Sucrose content of B. 3337 is the lowest of all varieties under commercial cultivation at present, but on account of its exceptional vigour, yields of sugar often exceed 5 tons per arpent on areas which seldom produced 3 tons with other varieties.

B. 37161 appears to be at its best in the humid zone, but it is doubtful whether this variety will ever become of importance as it is outclassed by B. 37172 and several local varieties.

B. 37172 has probably quite a future in Mauritius: it grows well in most localities, has a high sucrose content and a purity which remains high throughout the season. These advantages are offset by its hairiness and poor cover.

Concerning B. 34104, there are satisfactory reports from some areas, while in others its performance can only be classed as mediocre.

Approximately 425,000 canes of M. 147/44 and M. 31/45 were distributed for commercial planting during the year; these added to canes from other multiplication plots in the Island provided enough material to plant 2912 acres representing 25% of the 1956 plantations. Both these varieties are promising on account of their vigour, sucrose content and ratooning capacity. M. 147/44 appears to grow well in all localities, while M. 31/45 is better suited to regions of high and intermediate rainfall. Additional notes on these varieties and their average performance in pre-release variety trials will be read with interest in the Cane Breeding section of this report. A botanical description of M. 147/44 and M. 31/45 is in preparation.

It is interesting to review briefly the material available for future cane selection at the experiment stations of the Institute: 28,000 seedlings were planted from crosses made in 1956, and will be selected in 1958; 27,500 seedlings will be available for selection in August 1957; there are 1,285 selected seedlings in first selection trials, of which a final selection will be made in 1957 from amongst 366 seedlings now in 2nd ratoons. Pre-release variety trials on estates include 115 varieties. Ten foreign varieties are in multiplication plots while twenty are under observation in the quarantine greenhouse.

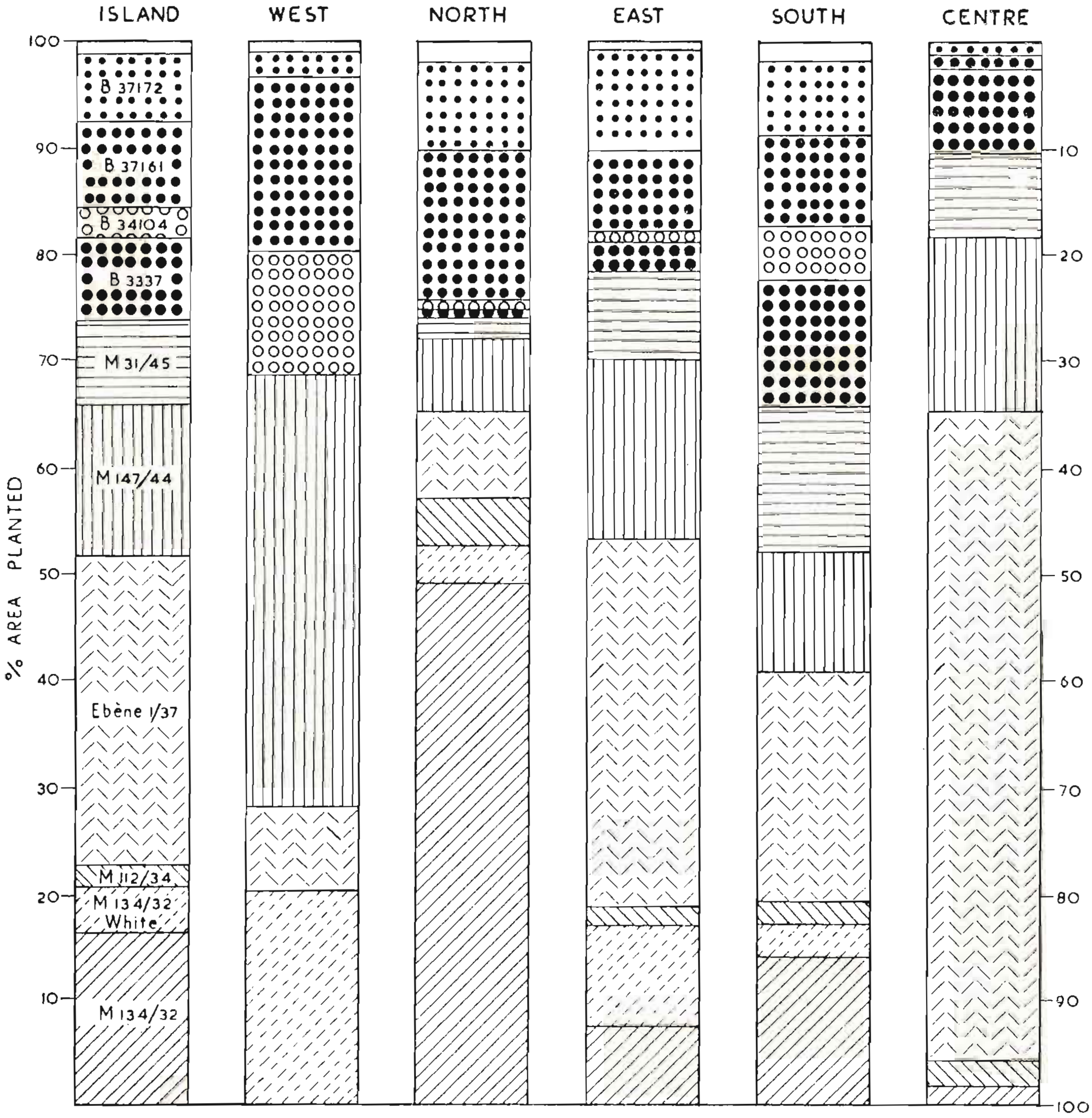

Fig. 3. Percentage area planted in different cane varieties on estates in 1956.

4. NUTRITION AND SOILS

During the last ten years chemical examination of a large number of correctly sampled cane leaves has revealed that approximately one-third of the area grown under sugar cane in Mauritius suffers from phosphate deficiency, and this despite fairly heavy dressing of phosphatic guano at planting. Thus it may be said that, while correct diagnosis can be effected, much has to be learnt yet as to the best methods to overcome phosphate deficiencies. In view of preliminary results obtained with superphosphate and recorded in the previous Annual Report, new experiments have been laid down to test the value of ammonium phosphate, triple and double superphosphate in improving the phosphate nutrition of sugar cane under local conditions. This aspect of fertilization is of particular importance in order to ensure maximum yields and prevent waste of fertilizers due to unbalanced nutrition. In this connection data published in the article on foliar diagnosis are of interest in showing the effect of phosphate and potassium deficiencies in the uptake of nitrogen by the plant.

The mineral composition of cane juice of six commercial varieties planted in post-release trials was studied in relation to potassium, phosphorus, calcium and magnesium. Details of these investigations are reported separately.

The series of lime and magnesia trials started in 1951 were reaped for the last time. Final results confirm the conclusions arrived at in 1954 that there is a response to lime on the gravelly soils of the super-humid zone. New experiments will be planted in 1957, using various combinations of calcium in an endeavour to obtain more information on this problem.

Through the courtesy of Mr. J. B. E. Patterson of Bristol, some preliminary trace element analysis of local soils have been obtained; these results are published and described in another section of this report.

Towards the end of 1955 the question of toxicity of fertilizer urea due to biuret as a contaminant was raised. In view of this possibility and because urea is now a competitor with ammonium sulphate, field experiments were laid down to compare these two fertilizers. The toxicity aspect is being studied in pot and laboratory experiments.

Routine analysis of 13,833 leaf samples for P_2O_5 and K_2O were carried out in 1956 in the Foliar Diagnosis laboratory for advisory purposes, the results being communicated to estates and planters concerned. In addition, determinations of N, P and K were made on 1250 leaf samples from experimental plots, while the N P K content of basal internode tissues in relation to leaf analysis was studied on 775 samples.

Work on a detailed soil survey of Mauritius is to start in 1957 and will be undertaken by the Chemistry Division of the Institute. The Department of Agriculture is co-operating in this research project by providing an analytical assistant, aerial photographs and maps, a jeep and by loaning a Beckman D.U. spectrophotometer with flame photometer attachment. A paper published in this Report gives a brief description of the local soils as classified by Craig and Halais and compares them in some respects with the soils of Hawaii. It is obviously important to correlate our soils with those of the Hawaiian islands not only from a pedological point of view but also because of the possible application of Hawaiian results on soil fertility studies to local conditions.

5. CANE DISEASES

Experimental work on cane diseases during the year was again concentrated on ratoon stunting and chlorotic streak, but with the changing varietal pattern, several diseases which had been in the background have appeared again. Thus several cases of smut (*Ustilago scitaminae* Syd.) were recorded on B. 37161 in the sub-humid zone; " pokkah-boeng " (*Gibberella fujikuroi* (Saw.) Wr.) was seasonally common on M. 31/45, M. 147/44, Ebène 1/37 and B. 37161, but did not cause serious damage; several cases of top rot brought about by this disease, however, were observed on M. 31/45. Mild attacks of red stripe (*Pseudomonas rubrilineans* (Lee *et al*) Dowson) occured on the Barbados varieties cultivated commercially. Growth failure of M. 134/32 due to root disease (*Pythium spp.*) was fairly common in some localities. Poor growth associated with ratoon stunting disease was again observed on M. 134/32 in regions of high rainfall; symptoms of the disease were seen on the white and striped sports of M. 134/32. Both B. 3337 and B. 37172 appear to be susceptible to the virus while Ebène 1/37 is proving more resistant so far. Observations made on chlorotic streak in field trials indicate the following susceptibility ratings of commercial varieties: M. 147/44, Ebène 1/37 and B. 37172 are highly susceptible; M. 134/32 and B. 3337 are susceptible; M. 31/45, B. 34104 and B. 37161 are moderately susceptible.

Routine testing of seedling resistance to gumming disease was carried out and six new varieties were found to be very susceptible. As there appears to be doubts in some quarters as to the value of these tests, it is important to stress that the Research Institute is continuing the well established policy of releasing only varieties which are highly resistant or immune to gummosis. This disease has been responsible for heavy losses in the past and for the disappearance from cultivation of many commercial varieties. In view of the widespread occurrence of the pathogen in other hosts in Mauritius, the eradication of the disease cannot be contemplated, hence the importance of assessing the reaction of new varieties at an early stage in the selection programme. N: Co. 310, which was released from quarantine in May 1956 was included in the gumming resistance trial, at the request of the Experiment Station, South African Sugar Association.

Experiments on treatment of cane setts in hot water and hot air, which are reported more fully elsewhere in this report, have revealed that stalk diameter is an important factor in connection with the temperature of tissues inside the cuttings. Thus a temperature of 50°C is reached in 30 minutes in cuttings having less than 3.5 cms diameter, while it takes up to one hour in thicker canes. The practical application of these observations is of fundamental importance in the control of ratoon stunting disease. It was also found that there is more even distribution of temperature (+ 0.1° C) in hot water tanks than in hot air ovens (+ 7.0° C). Treatment of setts in hot air therefore is not recommended for conditions prevailing in Mauritius, as the margin of safety for the inactivation of the virus, as well as for germination of cuttings, is greater in the hot water treatment.

Attention is drawn once more to the necessity of sterilising cane knives in order to prevent the spread of ratoon stunting disease.

Work on the possible chemical detection of ratoon stunting disease has continued but must be regarded as only a facet of the general biochemical investigations in progress. Detailed studies of sugar cane composition, in both the vegetative and reproductive stages, are being made and, at the same time, diseased and healthy plants are analysed and compared. Tests with oxidation-reduction indicators such as 2:3:5 triphenyltetrazolium bromide and 2:6 dichlorophenol-indophenol, which indicators have proved useful in the early detection of virus infection in some plants, have been tried with sugar cane but they have so far proved of no value.

Studies on the mode of transmission of chlorotic streak have indicated that there is no aerial transmission of the disease from infected to healthy stools. Investigations on the possible transmission of the disease through the soil are being actively pursued. It was also found that time of planting has an important effect on disease incidence. The semi parasite *Cassytha filiformis* is being used experimentally to transmit the disease.

Experiments to study the variation in susceptibility of stalks of various ages to red rot, (*Physalospora tucumanensis* (Went) Speg.) were resumed with M. 112/34 and M. 73/31: two varieties which differ in their commercial resistance by the ease with which the pathogen can penetrate the stalk. It does so readily in M. 73/31, but not in M. 112/34. Once penetration has been effected however, the rate of spread of the fungus in the tissues is approximately the same. These experiments confirmed previous findings that greatest susceptibility occurs at 15 to 17 months, after which period there appears to be resistance to invasion until 21 to 22 months. Preliminary results obtained are shown graphically in fig. 4.

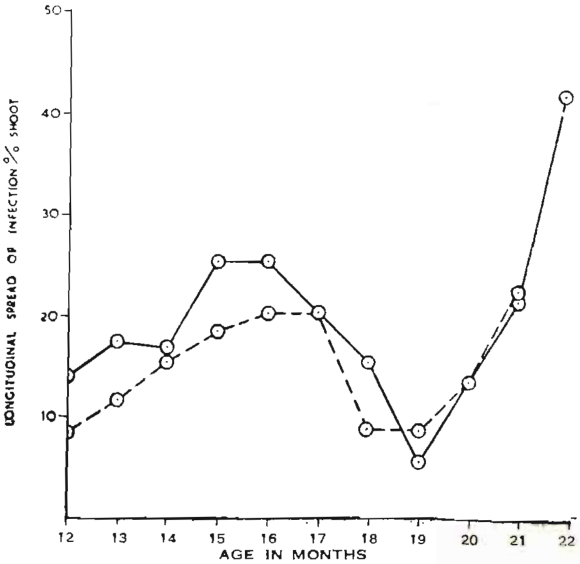

Fig. 4. Spread of *Physalospora tucumanensis* in inoculated stalks of M. 73/31 (broken line) and M. 112/34 (plain line).

The vigorous campaign conducted by the French authorities to eradicate Fiji disease from the East coast of Madagascar is producing fruitful results. Despite these efforts it is probable that the disease will not disappear completely for many years, hence the importance, so far as Mauritius is concerned, to have resistance trials established in Madagascar. It is interesting to note in this connection that the Entomology Division of the Department of Agriculture has successfully imported from Hawaii one of the predators (*Cyrtorhinus mundulus* Bred.) of the Fiji disease vector *Perkinsiella saccharicidae* Kirk.

6. CANE PESTS

The Research Institute is indebted once more to the Entomology division of the Department of Agriculture for its co-operation on all questions relating to insect pests of the sugar cane.

Outbreaks of the white grub *Clemora smithi* Arrow were reported in several localities particularly in the south and central sectors. Infestation reaching up to 94,000 grubs per arpent were recorded during larval surveys. It is interesting to note that high infestation was usually related to scarcity of the parasitic scoliid wasps *Campsomeris spp.*, the frequency of which depended in turn on the presence or absence of the food plant *Eupatorium pallescens.* The large scale use of hormone weed killers in cane fields is an important contributing factor to the disappearance of this useful plant. The suggestion is made here that Eupatorium plants growing in the vicinity of treated fields should be cut to ground level before herbicides are applied so as to prevent absorption of the chemical by the leaves; new growth arising from the stumps, flower in a relatively short time under Mauritius conditions. In order to attract Clemora parasites in infected localities, isolated plants of "herbe condé" (*Cordia macrostachya*) should be grown around cane fields; this species is resistant to hormone herbicides, and is not likely to invade cultivated fields in view of the successful parasitism of *Schematiza sp.* and *Eurytoma sp.*

Four trials on the control of Clemora by chemicals were laid down during the year using different concentrations of aldrin and gammexane.

The spotted borer *Proceras sacchariphagus* Bojer, was common in lowland localities early in the season. The newly released variety M. 31/45 appears to be susceptible but serious economic damage is not anticipated since the cultivation of this variety is recommended in the super-humid zone, where spotted borer attacks are less frequent. None of the borer parasites imported from the Carribean area several years ago were recovered from a survey conducted for that purpose.

7. WEED CONTROL

Further investigations were carried out this year on the herbicidal value of the substituted ureas with special reference to C M U and D C M U, and the effect of these compounds on cane growth. A series of new chemicals received during the year were tested with regard to their phytotoxic effect on the emergence of weeds of the humid and sub-humid localities; the small plot technique was used in these trials. Studies started in 1954 on the chemical eradication of 'Herbe sifflette' (*Paspalidium geminatum*) were resumed this year with new herbicides. Promising results were obtained with an application of a mixture of T C A and Dalapon.

The appearance of a new weed: 'Herbe Bleue' (*Verbena sp.*) in the Pamplemousses area has been a cause of much concern to sugar cane growers of that locality. Exploratory work on the control of this weed has so far failed to give satisfactory results.

A botanical study of the weeds of cane fields together with notes on their agricultural importance and methods of controlling them were started this year. The first leaflets describing about a dozen common weeds will be ready for publication in 1957.

8. OVERHEAD IRRIGATION

Preliminary investigations on overhead irrigation of sugar cane were carried out at Black River in 1953-54 by the Irrigation Committee of the former Natural Resources Board in co-operation with the Public Works Department, which supplied the funds.

In July 1954 the Institute was asked for advice in this connection and was eventually entrusted with the care of implementing new experimentation, which could give information of commercial value. A plan was accordingly drawn up on a basis of 40 arpents of experimental area to be extended to 125 arpents if necessary.

This plan was approved by the Board of Agriculture, Fisheries and Natural Resources and at the instance of this Board the Sugar Industry Reserve Fund Committee has agreed to contribute up to Rs. 100,000 over the next three years provided Government furnished another Rs. 50,000 as a re-vote of part of the balance remaining from the initial experiment.

The experiment will be conducted in the Black River district on "free" and gravelly soils, with conventional semi-portable equipment and diesel pumping unit of 100 h.p. The estate concerned has kindly co-operated by a detailed survey of the site of the experiment.

Meanwhile the Senior Field Officer, who had studied overhead irrigation in South Africa, gave advice to several estates. Advantage was also taken of a unit working at Constance Estate to obtain basic information on several aspects of overhead irrigation under local conditions.

Data on soil moisture, water retention capacity and growth of cane were obtained during the course of experiments described more fully in a special section of this report.

The assistance received from the two estates on which this work was carried out is gratefully acknowledged.

9. SUGAR TECHNOLOGY

The research activities of the Sugar Technology Division were confined chiefly to various problems relating to the boiling and crystallization of C — massecuites. In a comparative study of coil and calendria vacuum pans for the boiling of those massecuites the advantages of the latter over the former are brought into evidence under the conditions prevailing in Mauritius. In another study a comparison is made of air-cooled and water-cooled crystallizers, and the conclusion is drawn that the average cooling time of C — massecuites may be considerably reduced in Mauritius through the use of water-cooled crystallizers without any ill effect on the exhaustion of the final molasses.

Investigations on methods of cane analysis were also carried out and a study of the lead error in the polarisation of raw sugars was started jointly with the National Committee of I. C. U. M. S. A.

This division is responsible for the compilation of comparative factory data, a summary of which appears in this report. The Sugar Technologist was called to give advice on many occasions either to corporate bodies or to individual factories on such problems as creation of a hardboard plant in Mauritius using the so-called Barter process; possibility of using surplus bagasse in paper manufacture; erection and operation of pH controllers; preservation of cane juice.

GENERAL

Meetings. Two meetings of the Research Advisory Committee were held during the year to review the work in progress. Regional meetings were organised on several occasions at the four experiment stations, the subjects discussed being: new cane varieties; nitrogen and the sugarcane; recent investigations on ratoon stunting disease.

The Institute organized a display of the various aspects of the local sugar industry at the "Exposition des Maisons Claires" held at Curepipe in September and October. (Fig. 6 to 8).

Publications. The following publications were issued during the year:

Annual Report for 1955.

Bulletin: No. 6. A. de Sornay, Nouvelles Variétés de cannes.

Private Circulation Reports:

No. 5. R. Antoine, The Fiji Disease situation in Madagascar in 1956, mimeo., 38 pp. 1 fig., 3 maps, July 1956.

No. 6. E. Rochecouste, J. Dupont de R. de St. Antoine, G. Mazery, Report of the M.S.I.R.I. Delegates to the Ninth Congress of the International Society of Sugar Cane Technologists, India, 1956. Mimeo., 115 pp. Appendix, 2 maps, July 1956.

Revue Agricole et Sucrière de l'Ile Maurice:

Vol. 35, 131-138, Rochecouste, E., Le Neuvième Congrés International Sucrier.

ibid. 139-144, Rouillard, Guy., L'Emploi de l'Azote dans la Culture de la Canne à l'Ile Maurice.

ibid. 180-188, Dupont de R. de St. Antoine, J., En marge du 9ème Congrès de l'Isocate.

ibid. 250-260, Mazery, G., La Culture de la Canne à sucre dans l'Inde.

ibid. 298-309, Rochecouste, É., Le Désherbage Chimique à l'Ile de la Réunion.

Proceedings 9th Congress I. S. S. C. T. (in press)

Sornay, A. de, Recent Developments in Sugar-cane Breeding in Mauritius.

Rochecouste, E., Observations on Nutgrass (*Cyperus rotundus* L.) and its Control by Chemical Methods in Mauritius.

Eighteen bulletins on the evolution of the sugar crop were prepared and issued weekly, together with bulletins on comparative factory data ("Contrôle Mutuel").

STAFF MOVEMENTS

The Director was absent on overseas leave from 18th February to 3rd September. He visited Kenya in November to advise on possible developments of the sugar industry in that territory and also attended the 6th Conference of the Comité de Collaboration Agricole Maurice — Réunion — Madagascar, which was held in Tananarive on the 24th November.

The Institute was represented by the Botanist, Sugar Technologist and Senior Field Officer at the 9th Congress of the I.S.S.C.T., held in India in January and February.

The Agronomist was on overseas leave from August to December and attended the 6th International Soil Congress in Paris.

Visits of officers to Madagascar under the auspices of the "Comité de Collaboration Agricole Maurice-Réunion-Madagascar" included those of the Pathologist in February in connection with Fiji disease, the Chemist and Senior Assistant Chemist for soil studies, and the Chief Agriculturist who attended the annual session of that Committee.

It is my privilege in concluding this review of the year's work, to express my gratitude to all members of the staff and in particular to Mr. A. de Sornay, who acted for me during my absence on leave, for their co-operation, willingness and enthusiasm in the various activities of the Institute.

Director.

31st January, 1957

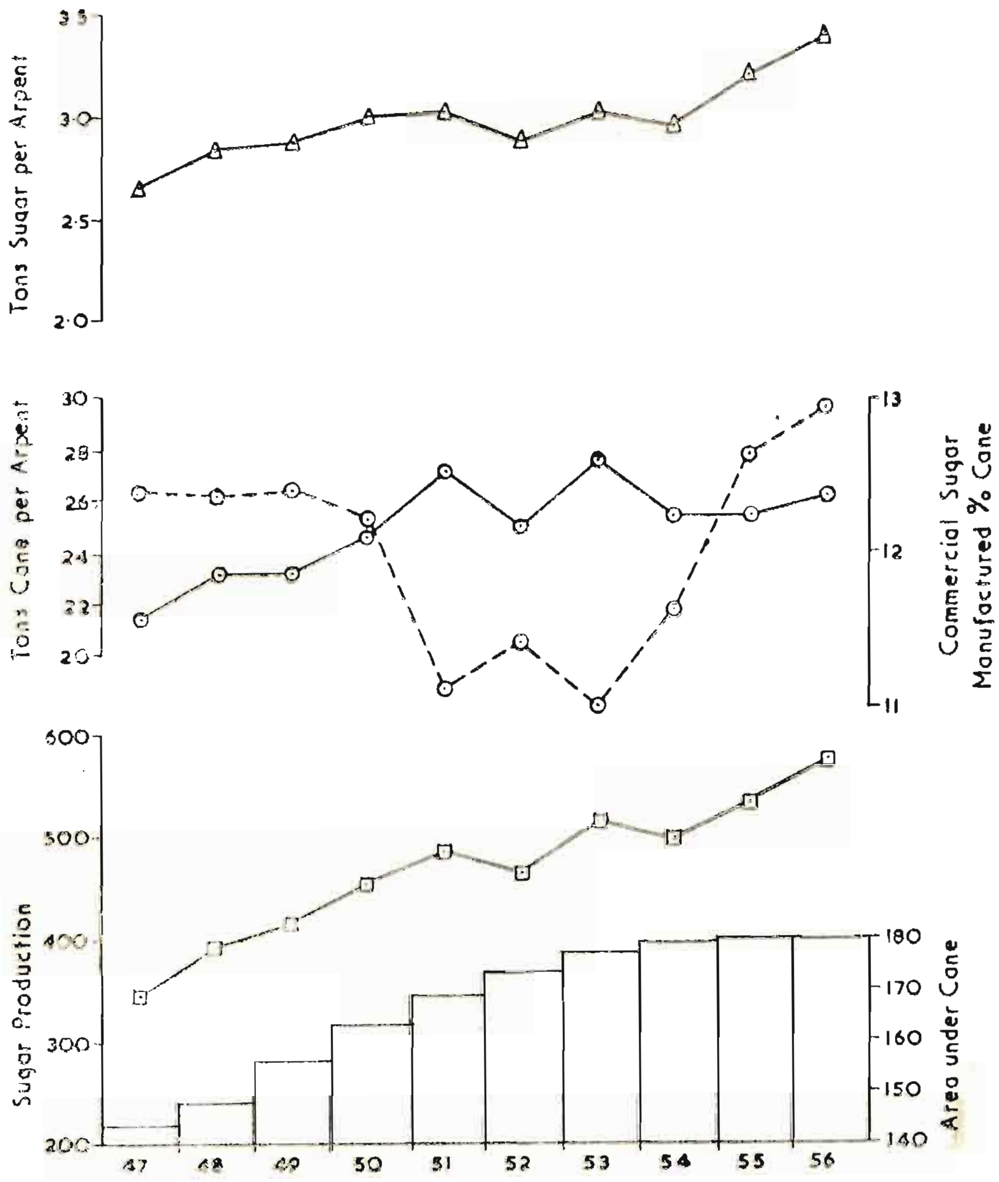

Fig. 5. Evolution of the Mauritius Sugar Industry 1947 -- 1956.

Area under cane in 1000 arpents : columns ; sugar production in 1000 metric tons : squares ; yield of cane : plain line (circles) ; commercial sugar manufactured % cane : broken line (circles) ; tons sugar per arpent : triangles.

Fig. 6.

Fig. 7.

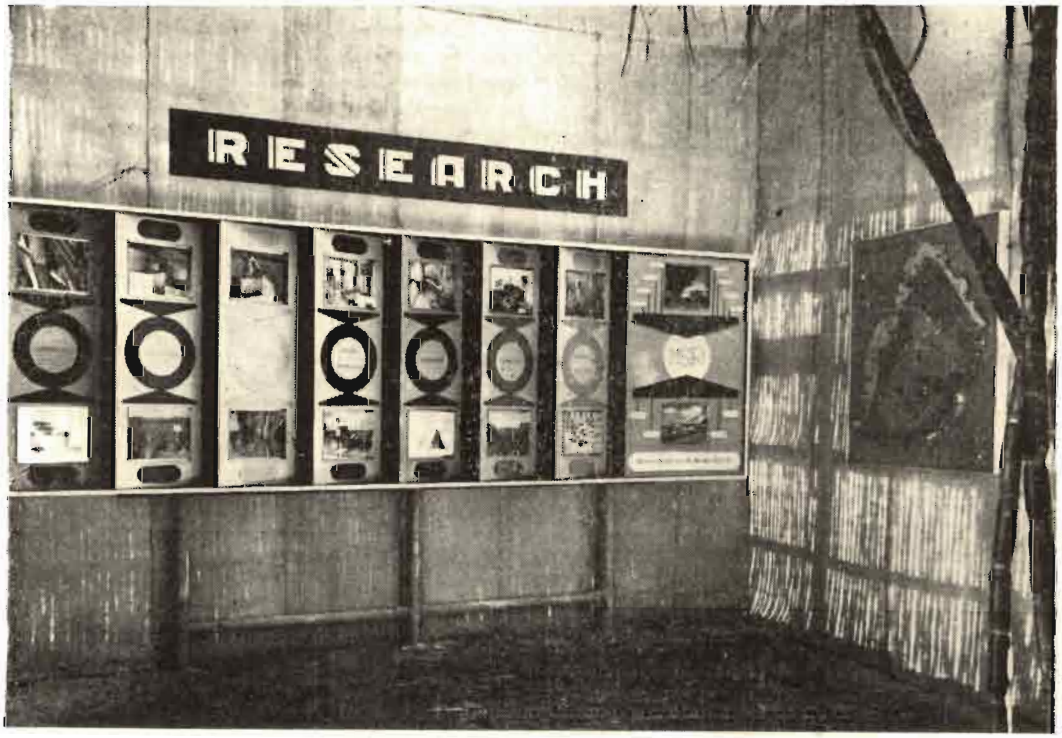

Fig. 8.

Part of The Sugar Industry stand at the Curepipe exhibition, September 1956.

CANE BREEDING IN 1956

A. de SORNAY

1. ARROWING

Up to 1955, the intensity of arrowing was estimated by means of visual observations and rated as profuse, medium or sparse. This year, it was decided to establish a more precise method of counting tassels. With this aim in view, a questionnaire was sent to all estates with factories so that arrow counts should be made according to a predetermined scheme. It is gratifying to record that the response has been satisfactory, and it was thus possible to obtain data from the five sectors of the island. Allowing for inevitable shortcomings, these data should prove of considerable value and reveal facts of importance such as for example, the effect of environment, variety, and date of previous reaping on flowering intensity.

With regard to sampling, the procedure adopted was as follows: for every estate totalling 500 to 1,000 arpents, arrows were counted in one or two fields of virgin canes — either short or long season, — while in the case of ratoons, fields were sampled at random so as to include canes reaped at monthly intervals the preceding crop. In each field examined, the number of arrows was counted in nine 10-foot plots of one line at random throughout the field, and in one plot of the same size in the border of the field.

Three important commercial varieties were included in the survey, namely M. 134/32, Ebène 1/37 and B. 3337. The last named variety only flowered to the extent of less than 1%, and is not included in the summarized data presented in table I.

Table 1. Arrowing in 1956

Arrows %				
Sector	Virgins		Ratoons	Average
	Long-season	Short-season		
	M. 134/32			
North	20.6	19.7	31.4	23.9
South	20.0	10.1	30.8	29.4
East	16.0	—	17.6	17.3
West	12.1	11.5	6.2	7.4
Centre	—	—	18.7	18.7
Average	18.0	12.0	24.8	22.5
	Ebène 1/37			
South	32.9	3.9	19.7	16.8
East	10.4	8.1	14.9	14.1
Centre	7.9	2.8	11.9	10.8
Average	10.6	4.1	14.6	13.1

M. 134/32 has flowered to the extent of 23 % on the average and Ebène 1/37 to the extent of 13 %. Arrowing in M. 134/32 has been more pronounced in the north and south sectors, being of the order of 45 % in some localities, and attaining 55 % on one estate. For both varieties, long season virgin canes flowered more than short season canes as was to be expected, while ratoons showed a higher rate of arrowing than virgins. Except for the western sector, there seems to be a diminution in arrowing with altitude, a phenomenon which has also been observed in other countries. A more detailed analysis of the data obtained will be made later with a view to establishing a probable relationship between arrowing, rainfall and other factors.

The effect of age of the ratoon crop (date of previous harvest) has naturally a marked effect on flowering, the older the canes the greater being the percentage of arrows (fig. 9), the data obtained suggesting a linear relationship between these variables.

That tasseling is more intense in the border than in the middle of cane fields is a common observation, but this difference is probably a function of arrowing intensity. It is higher when flowering is light and tends to even out with higher percentages. These observations appear to be confirmed by the data obtained in 1956 which was a fairly heavy arrowing year. The percentage of arrows in different parts of the fields was as follows:

Variety	*Border rows*	*Middle rows*	*Ratio*
M. 134/32	25.0	23.3	1 07
Ebène 1/37	13.3	12.1	1.09

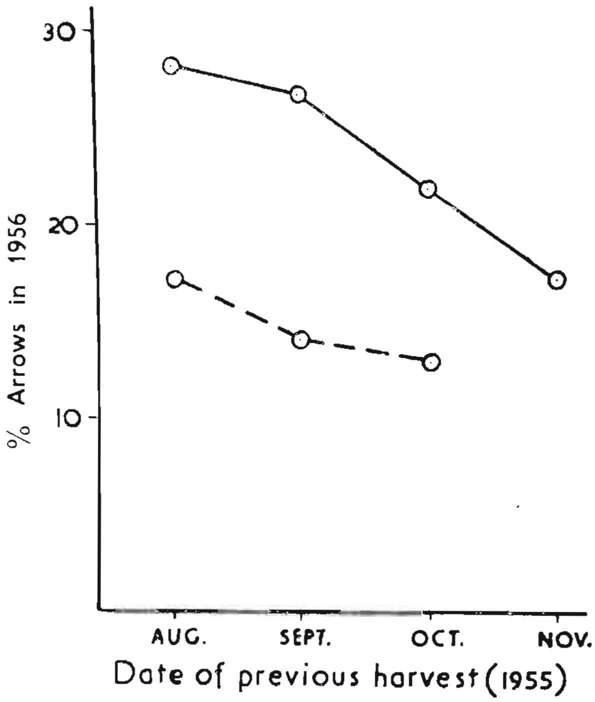

Fig. 9. Relationship between arrowing in ratoon canes and date of reaping. Plain line M. 134/32 ; broken line Ebène 1/37.

2. CROSSING

Weather conditions were more favourable for arrowing and hybridization than in 1955, and the breeding programme could be carried out more or less as planned out. Crosses made at Réduit and Pamplemousses totalled 390, as against 181 in 1955 (see table XIII of Appendix).

Many interesting crosses were represented and included combinations with valuable varieties such as B. 34104, B. 37161, B. 37172, Co. 421, Ebène 1/37, M. 134/32, M. 112/34 and P. O. J. 2878. New parent varieties were: B. 41227, M. 93/48, M. 99/48, M. 142/49 and Pindar.

B. 3337 has, for the first time, produced a fairly large number of seedlings when used as female and mated to M. 147/44. B. 34104 has been particularly prolific when used as female; it appears in 54 crosses, and has, for the first time, produced a large progeny on being used as a staminate parent and crossed with certain female varieties such as Ebène 1/37, M. 134/32, M. 112/34 and P.O.J. 2878. B. 37161 was, as usual, of low to very low fertility, and there are few chances of selecting a high-class variety from its derivatives. B. 37172 was used as male with little success; it gives, in general, better results as female. Co. 421, one of the parents of the famous N: Co. 310, has been used in many crosses, with disappointing results. Ebène 1/37 is well represented in the hybridization work, and has been up to the mark with regards to its female fertility: a large number of seedlings was obtained from different combinations, including M. 134/32 and M. 147/44. M. 241/40, a variety of high vigour, has at last been used successfully and has produced offspring in sufficient quantity. The variety Pindar yielded no seedlings at all when crossed with three parent varieties.

One of the best parents, from the point of view of prolificity, was M. 147/44, which appears in a large number of combinations. It is fortunate that it is proving to be a strong male, as the breeding work is suffering from a dearth of male parents. M. 31/45, which is a shy arrower, yielded seedlings for the first time when crossed with M. 134/32 and M. 112/34.

It is interesting to record that the cross *Saccharum spontaneum* x *S. robustum* gave 331 seedlings, and the reciprocal cross, 1,025 seedlings from two arrows.

B.H. 10/12 flowered in an experimental breeding plot at California estate in the north as well as Ebène 1/37, with which it had been inter-planted. Unfortunately news that B.H. 10/12 had arrowed came too late, and when the plots were examined, all the arrows were in an advanced state of protrusion, and not worth while using in crossing. The few arrows that had just emerged were prevented from developing normally because of side shoots. All the arrows available were collected, but the fuzz produced no seedlings on being sown.

Back crosses comprised the following:

B. 34104 x M. 142/49 (B. 34104 x M. 63/39)

M. 142/49 x B. 34104

M. 112/34 x M. 164/53 (M. 112/34 x M. 63/39)

Ebène 1/37 x M. 716/51 (Ebène 1/37 selfed)

All the crosses have yielded sufficiently large seedling populations for experimental purposes, and it is hoped that enough seed has been produced to reproduce the gene frequencies characteristic of the recurrent parents.

Sib-crosses included M. 379/51 x M. 381/51 and the reciprocal cross (both components of this combination being derived from the cross B. H. 10/12 x M. 63/39), and M. 167/53 x M. 164/53, each of the parent varieties having originated from the cross M. 112/34 x M. 63/39. No seedlings have been produced from these sib-crosses.

Crosses made to compare the progeny obtained from hybridization between certain females and a male parent, and between these females and the self of this male parent comprised :

B. 34104	x	Ebène 1/37
,,	x	M. 716/51
M. 134/32	x	Ebène 1/37
,,	x	M. 716/51
M. 129/43	x	Ebène 1/37
,,	x	M. 716/51

The seedlings populations from the above crosses will be compared at selection to determine whether crosses made with the selfed parents yield more valuable progeny than those made with the original parents themselves.

As mentioned in the Annual Report for 1955, a breeding plot including commonly used male parent varieties has been planted at Richelieu Experiment Station of the Department of Agriculture. Crosses involving certain females were made in pairs nearly simultaneously with male arrows from both Réduit and Richelieu. The average number of seedlings per cross obtained with male arrows from Richelieu was 185, as compared to 100 from Réduit, thus showing the higher pollen fertility of the male arrows from Richelieu. The test, however, could be conducted on a restricted scale only, most of the arrows at Richelieu having protruded earlier than those at Réduit. Next year it is intended to treat the male plot at Richelieu with maleic hydrazide to delay arrowing, so that more experimental crosses can be effected at Réduit.

Concerning selfings, one clone from the *Saccharum spontaneum* selfed progeny arrowed at Réduit, but produced no seedlings on selfing.

M. 147/44 was selfed and one arrow gave only twelve seedlings. M. 716/51 (Ebène 1/37 selfed) was also selfed and yielded two seedlings. Thus, as past experience has shown, seedling populations from selfed arrows are very seldom large.

As compared to last year, the seed-bearing fuzz was more fertile at Réduit but less so at Pamplemousses. At both Stations, a large number of experimental crosses produced no viable seed at all.

The fuzz was sown in the standard soil-manure mixture. The mixture was sterilized in a sterilizer made by the General Electric Co. Ltd., and having an internal capacity of one fourth cubic yard. The soil is heated to 82° C and the current switched off. The temperature rises to 100° C after 20 minutes and is kept at this level for 10 minutes, the soil being thereafter discharged. The operation is carried out some days before planting the fuzz.

No cases of damping-off and absolutely no weeds were noticed in the seed pans.

At Réduit the greenhouse was heated at night and during cold days with two electric stoves, with apparently good results.

Seedlings were transplanted in November and December. Bunch planting of seedlings was made on a small scale at Réduit for experimental purposes. A latin square was laid down to compare two methods of bunch planting with ordinary space planting. In the first method, there were seven seedlings per pot and one pot per hole, and in the second, one seedling per pot and 7 pots per hole.

Each plot consists of 3 rows of 10 holes. There are, therefore, 630 seedlings per plot in the bunch-planted plots and 90 seedlings per plot in the control plots. At the time of writing this report, the bunch-planted seedlings, all from the same cross, are bigger than the space-planted ones, particularly in the plots in which there are seven plots per hole. The same phenomenon was observed in the seedlings planted in bunches in 1955, which showed a spectacular advance as compared to the space-planted seedlings. This excess of vigour can probably be explained in terms of competition for growth between the seedlings in the same hole whether in one or several pots. Artificial fertilizers applied per hole remained constant irrespective of the number of pots per hole.

A summary of the breeding work in 1956 is shown in table 2, while crosses made are listed serially in table XIII of the Appendix.

Table 2. Summary of breeding work in 1956.

Experiment Stations	Number of crosses made	Number of seedlings obtained	Number of seedlings transplanted
Réduit	194	9,295	9,281
Pamplemousses	196	23,088	11,278
Belle Rive	—	—	5,010
Union Park	—	—	2,630
Total	390	32,383	28,199

3. SELECTION

A total of 686 seedlings has been selected from the first-ratoon populations at the Experiment Stations and planted in multiplication plots consisting of single rows 10 ft. long of each selection, there being a row of a control variety after every four or five selections.

At Réduit, seedlings which had been selected in plant cane were re-examined in ratoon, and only 42% of those chosen in virgins were re-selected. Selection was based mainly on Brix, general appearance and freedom from diseases. The correlation coefficient between the Brix in virgins and ratoons was $+ 0.334 \pm 0.063$, and of the same order of magnitude as the coefficients found before.

At Belle Rive, the selected varieties of the M./53 series planted in a multiplication plot in 1955 were re-selected in August. 51 varieties, representing 32% of the original selections were chosen for planting in first selection trials which now consist of three randomised blocks with plots 15' long and one row wide.

The percentage of seedlings re-selected for Brix alone was 47% and the percentage re-selected for appearance only was 63%. It is thus a lower Brix compared to the control variety which appeared responsible for lower selection rates in the multiplication plot. The above results emphasize the need for including selections from ratoon seedling populations in propagation plots prior to their being tested in first-selection trials.

The varieties in first-selection trials were selected in August as usual, and 44 selections planted in propagation plots at the respective Experiment Stations prior to including them in pre-release trials on estates in 1957. The variety M. 272/52, which performed extremely well in virgins and first-ratoons, as compared to Ebène 1/37, was selected and multiplied pending the final results in second-ratoons in 1957; it will be tested in a pre-release trial in 1957.

4. PRE-RELEASE VARIETY TRIALS

Nine trials have been planted in 1956, three in the sub-humid zone, one in a locality of high rainfall and one on an irrigated estate. This distribution gives greater bias to variety testing in low rainfall areas as compared to that of previous years. These trials comprise mainly varieties of the M./50 and M./51 series, Ebène 1/44, R. 366, R. 397, B. 41227, P. O. J. 3016 and Pindar. M. 202/46, which has responded well to humid conditions, has also been included in three of these trials.

Thirty three pre-release trials have been harvested during the year. The results obtained with the varieties M. 129/43, M. 147/44 and M. 31/45 are summarized in table 3, while their maturity behaviour compared to M. 134/32 is given in table 4.

Table 4. Maturity behaviour of M, 129/43, M. 147/44, and M. 31/45 as compared to M. 134/32.

Variety	JULY-AUGUST		SEPTEMBER-OCT.		NOVEMBER-DECEMBER	
	No. of harvests	C. C. S.	No. of harvests	C. C. S.	No. of harvests	C. C. S.
M. 129/43	27	+ 0.8	36	+ 0.8	17	— 0.3
M. 147/44	23	+ 0.6	32	— 0.3	20	— 0.3
M. 31/45	37	— 0.1	58	+ 0.2	15	+ 0.1

The above figures comprise a higher proportion of ratoons than those published last year and should be more reliable. It appears that both M. 129/43 and M. 147/44 are early maturing varieties, and should be cut at the beginning of the crushing season, while M. 31/45 is medium maturing.

The complete results obtained with the three varieties since they have been included in trials under diversified environmental conditions are summarized in table 3. The important points which emerge from these records are:

(a) M. 129/43 is on a par with M. 134/32 in yield of cane, but is slightly superior in yield of sugar due to its better juice. It will be kept under further observation, and its productive figures obtained in older ratoons before a decision is made concerning its release for commercial cultivation. M. 129/43 appears superior to M. 134/32 under irrigated conditions.

(b) M. 147/44 has given an excellent account of itself in plant cane and ratoons, and is superior to M. 134/32 by a wide margin, except in the sub-humid zone where it is only slightly better than the control variety. Its tendency to produce side shoots has been less pronounced than in 1955. This variety is unfortunately very susceptible to chlorotic streak (same rating as Ebène 1/37) and its fibre content is higher than that of M. 134/32. The results of tests made to gauge rapidly its ratooning capacity indicate high ratooning qualities in the three rainfall zones of the island. M. 147/44 appears to be adapted to a wide range of environmental conditions suggesting drought resistance as well as tolerance to excessive humidity.

(c) M. 31/45 is a vigorous cane which has also performed exceptionally well in both plant canes and ratoons. Its juice quality is as good as that of M. 134/32 but is inferior to that of Ebène 1/37. It is slightly more fibrous than M. 134/32. It is better adapted to

Table 3. Summarized performance of M. 129/43, M. 147/44, and M. 31/45 in pre-release variety trials

Category	No. of harvests	Tons cane per arpent		Sig. diff.	Juice Purity		C. C. S. % Cane		C. C .S. per arpent		Sig. diff.	Fibre		Climatic Zones
		129/43	134/32		129/43	134/32	129/43	134/32	129/43	134/32		129/43	134/32	
Plant Cane	11	34.74	35.54	3.15	87.2	85.7	13.3	12.6	4.63	4.48	0.40	—	—	Sub-humid, humid and irrigated
Ratoons	16	30.75	29.33	1.59	90.9	90.6	14.7	14.6	4.51	4.38	0.23	—	—	
Average	27	32.37	32.18	2.22	89.4	88.6	14.1	13.7	4.56	4.42	0.33	—	—	
		147/44	134/32		147/44	134/32	147/44	134/32	147/44	134/32		147/44	134/32	
Plant Cane	11	46.90	37.49	5.14	89.5	87.7	14.0	13.2	6.58	4.95	0.69	11.3	10.4	Sub-humid, humid, super-humid and irrigated
Ratoons	14	39.80	31.81	2.26	90.3	90.3	14.8	14.8	5.90	4.72	0.33	11.9	10.2	
Average	25	42.92	34.86	2.30	89.9	89.2	14.5	14.0	6.20	4.82	0.32	11.7	10.3	
		31/45	134/32		31/45	134/32	31/45	134/32	31/45	134/32		31/45	134/32	
Plant Canes	15	44.80	34.31	5.90	85.2	84.6	12.5	12.0	5.61	4.14	0.72	9.6	9.4	Sub-humid, humid, super-humid and irrigated
Ratoons	33	35.81	28.91	0.62	89.0	88.7	13.8	13.7	4.93	3.97	0.08	10.7	10.1	
Average	48	38.64	30.60	1.45	87.8	87.5	13.3	13.2	5.15	4.03	0.02	10.4	9.9	
		31/45	E. 1/37		31/45	E. 1/37	31/45	E. 1/37	31/45	E. 1/37		31/45	E. 1/37	
Plant Canes	5	35.58	29.20	7.02	84.5	85.7	11.6	12.2	4.11	3.55	0.82	9.5	8.7	Super-humid
Ratoons	15	34.21	31.43	1.42	89.2	90.3	13.0	14.0	4.45	4.41	0.19	10.1	9.6	
Average	20	34.55	30.88	1.74	88.0	89.2	12.6	13.6	4.37	4.19	0.22	9.9	9.4	

regions of high and medium rainfall and may even withstand waterlogged conditions. M. 31/45 is susceptible to the spotted borer (*Proceras sacchariphagus*) but appears moderately resistant to chlorotic streak. The ease with which it is trashed is a valuable asset.

Both M. 147/44 and M. 31/45 have been added to the list of approved varieties. The number of canes distributed to planters is mentioned in the Introduction.

Yield figures for M. 311/41, which appears promising under irrigation in the warmer districts of the Island, are as yet too fragmentary for an appraisal of its commercial value under such conditions.

Trials comprising the white and striped sports of M. 134/32 have been reaped in ratoons, but owing to paucity of data it cannot be said whether they will equal or outclass the mother variety.

A study of table 3 shows the low order of magnitude of the significant differences between the mean yields of the varieties referred above and M. 134/32. These figures have become much reduced with an increase in the number of tests and are remarkably accurate.

Promising varieties from other trials are: M. 202/46 (Co. 281 x M. 63/39) which has been planted in three trials in 1956, M. 93/48 (B. 34104 x M. 213/40) and M. 253/48 (B. 34104 x M. 213/40).

Ratooning capacity of Barbados varieties

One trial in 5th ratoons and five in 7th ratoons have been cut to assess the ratooning capacity of four released Barbados canes in comparison with M. 134/32. The results, appended in table 5, show that B. 3337 is far superior to the control variety in yield of cane, while B. 34104, B. 37161 and B. 37172 have approximately the same ratooning capacity as M. 134/32.

Table 5. Performance of B. 3337, B. 34104, B. 37161 & B. 37172 in ratoons.

Category	Tons cane per arpent				
	M. 134/32	B. 3337	B. 34104	B. 37161	B. 37172
Fifth & Seventh ratoons	31.04	42.04	33.04	30.54	33.14
Difference	—	+ 11.00	+ 2.00	— 0.50	+ 2.10

5. IMPORT AND EXPORT OF CANE VARIETIES

The varieties imported in 1954, namely, Q. 44, Q. 47, Q. 57, 27 M. Q. 1124, 28 M. Q. 1370, U. S. 48—34, Co. 779, P. R. 1000, B. 4362, H. 37—1933 and N: Co 310, and released from quarantine, have been propagated at Réduit. E.P.C. 39—393 and Pepe Cuca were destroyed in the quarantine greenhouse, the former because of its general unsatisfactory growth, and Pepe Cuca because it exhibited symptoms of ratoon stunting disease in spite of the fact that the cuttings had been treated with water at 50°C. for two hours; it may have harboured a strain of R. S. D. resistant to the ordinary hot water treatment.

The following varieties have been imported in 1956:

From Australia: 39 M. Q. 832; 39 M. Q. 841; 36 M. Q. 217; 30 M. Q. 985; 47 R, 2777; 47 R, 4066; 4 OS. N. 5819; Eros, Korpi; Orambo; Ragnar; Vesta; Q. 50; Q. 56; Q. 58 and 51 N. G. 142.

From South Africa: B. 4744, C. B. 38—22; N: Co. 376; P. T. 43—52.

Cuttings of the following varieties have been exported in 1956:

South Africa : Q. 44 ; Co. 779, P. R. 1000 ; U. S. 48—34.

Argentina : M. 112/34 ; M. 165/38 ; M. 63/39 ; M. 76/39 ; Ebene 1/37.

Iran : M. 112/34 ; Ebene 1/37 ; B. 34104 ; B. 37161 ; B. 37172.

Reunion : M. 147/44 ; M. 31/45.

Egypt : M. 134/32 ; Ebene 1/37.

Java : M. 134/32 White Sport ; M. 112/34 ; M. 241/40 ; M. 147/44 ; M. 31/45 ; M. 381/51 ; Ebene 1/37 ; M. 336 ; P. R. 905.

Australia : M. 11/43 ; M. 147/44 ; M. 31/45.

Madagascar : M. 31/45 ; M. 147/44 ; R. 366 ; R. 397 ; Trojan.

6. INDUCTION OF ARROWING

Experiments conducted at Réduit and Pamplemousses to try to induce arrowing in R.P. 8, B. H. 10/12 and Black Tanna by means of heliotropic stimulation of the stalk have again given negative results. The canes were split open longitudinally at the end of the experiment, but no arrows were found. The method will be discontinued.

The small R. P. 8 and B. H. 10/12 plots planted in different localities failed to tassel except the one at California as already reported. It is intended to increase the size of that plot in 1957.

The Plant Breeder of Mount Edgecombe Experiment Station, South Africa, has been approached with a view to including R. P. 8 and B. H. 10/12 in his experiments to induce flowering by means of photo-periodism. Should the canes respond to the photoperiodic treatment, a dark chamber may be erected locally.

7. RATOONING CAPACITY OF NEW VARIETIES

The aggregate yield of shoots and green leaves in the latin squares at the four Experiment Stations, and referred to in the 1955 Report, are given in Table 6.

Table 6. Ratooning capacity of new varieties.

Station	Category	Avg. age (mths.)	Treated at 50°C for 2 hrs.	Mean yield (kgs) of shoots & leaves				
				M. 171/30	M. 134/32	M. 129/43	M. 147/33	M 31/45
Pamplemousses	1st to 7th ratoons	3½	Untreated	—	30.8	32.6	39.2	39.4
,,	1st to 6th ratoons	3½	Treated	16.5	23.9	27.7	36.4	36.9
Belle Rive	1st to 4th ratoons	5	,,	5.7	5.3	8.2	20.1	16.9
Union Park	1st to 4th ratoons	5	,,	16.8	15.4	19.0	46.3	32.6
Réduit	1st to 3rd ratoons	4	,,	14.6	27.7	33.3	34.7	31.0

The above yield figures are in good correlation with those in table 4, except those for M. 129/43 which appear somewhat exaggerated.

The differences in yield between the treated and untreated latin squares at Pamplemousses are small but consistent; they cannot, however, be ascribed to one particular growth factor, such as the effect of ratoon stunting disease, as the first reapings did not take place at the same time.

The data in table 6 give a clear indication that M. 129/43 ratoons as well as M. 134/32, while M. 147/44 and M. 31/45 have a higher ratooning capacity particularly under super-humid and irrigated conditions.

The average age of the ratoons is naturally shorter at Pamplemousses than in the uplands: $3\frac{1}{2}$ months, as against 4 to 5 months at Réduit, Belle Rive and Union Park. At Pamplemousses, the virgin crop and six to seven ratoons have occupied the land for a little above two years; under normal cultivation conditions, the complete rotation would have taken seven to eight years, so that the ratoon experiments really give rapid indications of the ratooning capacity of the varieties under test.

The latin squares will be kept until the 8th ratoon stage and the canes allowed to grow for twelve months before harvesting to determine if the treatment has had any effect on the final yield of cane.

8. EFFECT OF ENVIRONMENT ON ANTHER FERTILITY

Studies on the effect of environment on the percentage of open anthers in M. 63/39 and Ebène 1/37 have been continued and extended to the varieties Co. 419, B. 34104, P. O. J. 2878 and M. 423/41.

The three first varieties show a proportionate decrease in male fertility with altitude in the same manner as M. 63/39 and Ebène 1/37, but they could not be surveyed on a large scale, as Co. 419 and P. O. J. 2878 are only to be found at the Experiment Stations, while B. 34104, released for commercial growing in 1956, is still planted on a small scale. M. 423/41, a strong male parent, was also investigated, but arrows of this variety were available in a few localities and none were found at the higher altitudes. In all localities studied, it exhibited a high percentage of open anthers (88 — 98%), so that it cannot be said whether the effect of altitude on anther opening, as met with in the varieties investigated so far, holds good for M. 423/41.

The data received from Réunion island are too scanty for analysis.

9. FUZZ STORAGE

Half of the fuzz from six crosses was stored in muslin bags in a sealed tin kept in a refrigerator at 8° — 10° C for about five months. The fuzz was dried at 35° C for five to six hours before storage. A little calcium chloride was placed inside the container, to absorb any trace of free moisture, and prevented from coming into contact with the fuzz by means of a plug of several layers of filter paper.

An electrically heated box of simple design was used for drying the seed. Briefly, the apparatus consists of a wooden box 15″ high and 10″ x 10″ in cross section. The box is provided with a hole 2″ in diameter at the bottom, and a thin wire-gauze shelf 6″ from the bottom. A second shelf lies about 1″ above the first and supports the muslin bags Care is taken to prevent packing of the bags to ensure adequate ventilation. The box is fitted with a wooden lid and a thermometer whose bulb reaches the topmost bags.

An ordinary electrical hair drier is placed underneath the box, and the flow of hot air entering the box is controlled by carefully adjusting the distance between the nozzle of the drier and the bottom of the box.

Half of the fuzz was sown in August 1955, that is, a few days after collection, and the other half, maintained in cold storage, was sown in January 1956. The results obtained are shown in table 7.

There has thus been considerable improvement in germination of the fuzz after storage at low temperatures. The seed fertility has, in fact, more than doubled, and the time for germination was shorter, suggesting that the seed should go through a period of dormancy before sowing.

Half of the fuzz from 30 to 50% of the crosses to be made in 1957 will be stored and sown towards the end of summer in 1958.

If the results are satisfactory, it might be advisable to store the fuzz from crosses made any one year and plant it the following year. This procedure will have the advantage of producing more seedlings and of allowing the fuzz to be planted during a more suitable season, thereby ensuring higher germination rates.

Table 7. Results of Fuzz Storage Experiments.

Cross No.	First date of sowing	Date of germination	No. of days for germination	No. of seedlings obtained	Second date of sowing	Date of germination	No. of days for germination	No. of seedlings obtained
1835 P	27.8.55	30.8.55	3	610	11.1.56	13.1.56	2	830
1838 P	”	31.8.55	4	112	”	”	2	1,920
1844 P	12.9.55	15.9.55	3	404	”	”	2	660
1846 P	2.9.55	5.9.55	3	265	”	”	2	160
1849 P	12.9.55	15.9.55	3	116	”	”	2	460
1850 P	”	”	3	151	16.1.56	19.1.56	3	110
TOTAL				1,658				4,140

NUTRITION AND SOILS

1. THE COMPOSITION OF CANE JUICE

D. H. PARISH

THE INFLUENCE OF VARIETY AND OTHER FACTORS ON LEVEL OF SOME ASH CONSTITUENTS OF JUICE

ONE of the principal items of the research programme of the Chemistry Division is a detailed study of the organic composition of the juice of different cane varieties grown under different conditions of fertility and climate.

This work presented, during 1956, an opportunity for the estimation of several of the more interesting ash components of juice. As very little information on the levels and variability of these inorganic constituents in the juice of the newer varieties grown in Mauritius is available, it was felt that the data obtained would prove of interest and the results are therefore presented in this paper.

Much information has been published on the mineral content of whole cane, tops, trash and juice. Systematic analytical studies first made in Java were followed by similar work in many other countries. The work carried out by Craig and Halais (1) in Mauritius covered a broad field, the aim being to thoroughly test the possibility of using juice analyses as a guide to the rational fertilization of the cane plant. The results of these studies led to the abandonment of juice analyses and to the introduction of foliar diagnosis. Feillafé (2) studied the influence of climatic factors on the mineral composition of various parts of the cane; however this work and that of Craig and Halais has been to some extent outdated by changes in the varietal picture discussed below. The analyses carried out by Fort and Mc Kaig (3) in Louisiana were particularly detailed as regards the influence of variety on the mineral composition of the juice, the work being primarily designed to give information on clarification properties.

In all these studies, the following factors, amongst others, which are operative locally and which may be expected to influence the composition of cane juice, have not generally been studied:

1. About 85% of the cane crushed comes from ratoons harvested when twelve months old. Differences between ratoon canes occur depending on the actual month in which they are harvested. As the crushing season lasts approximately five months the ratoon canes may have grown during the period July — July or November — November.

2. The effect of local variations in climate is important. The drier cane areas average a rainfall of about 40" per annum, whilst the wetter average about 90".

This rainfall factor is important from two aspects as not only does it affect cane growth directly, but the soils in the areas of high rainfall are highly leached and there is, therefore, the indirect effect due to the canes growing on land with a poor base status. This deficiency of bases does not normally cause a loss in cane yield but, nevertheless can and does cause a lowering of the mineral level in the juice as is demonstrated in the results presented here.

3. The phosphorus and potassium status of the bulk of local soils are not such as to

be limiting factors to cane growth, and in those places where deficiencies do exist they should normally be remedied by fertilizer application.

4. The level of nitrogenous fertilization used generally has a profound effect on yields.

5. The varieties now grown in Mauritius include two canes of local origin which together cover some 90% of the total cane area. The recently released Barbadian varieties studied in this work are proving popular and are being planted on an increasingly larger scale.

The samples used were obtained from replicated trials which were designed to cover the wide range of conditions met with locally.

EXPERIMENTAL

The samples of juice used in this work were obtained from the first ratoons of the post-release trials planted in June 1954 and harvested as virgins in July, September and November 1955. The ratoon crops were harvested exactly one year after the virgin crops thus giving three groups of twelve months old canes harvested at the beginning, the middle and the end of the crushing season respectively.

The trials consist of the following six varieties:

1. B. 34104
2. B. 3337
3. B. 37161
4. B. 37172
5. Ebène 1/37
6. M. 134/32

each receiving three different levels of nitrogenous fertilizer in the form of sulphate of ammonia applied at the following rates:

N_1. Low level of nitrogen application 20 Kgs. N/arpent.

N_2. Medium level of nitrogen application 40 Kgs N/arpent.

N_3. High level of nitrogen application 60 Kgs. N/arpent.

Potassic and phosphatic fertilization is optimal. Only two of the trials were sampled, the one at Bonne Veine (120″ rainfall) being taken as typical of the wetter districts of the island and the other at Bon Espoir (40″ rainfall) as typical of the drier districts.

The juice samples were prepared by the procedure normally used in this Institute.

The determination of the individual elements was carried out as follows:

(i) Potassium — by flame-photometer following carefully controlled dry ashing.

(ii) Calcium and Magnesium — by the versenate method described by Honig (4).

(iii) Total and Inorganic Phosphorus — by the molybdate method, the inorganic phosphorus being determined directly on the diluted juice and the total phosphorus following wet digestion with sulphuric acid and hydrogen peroxide.

RESULTS AND DISCUSSION

Potassium

The principle inorganic component of the ash of cane juice is the alkali potassium (expressed as K_2O); sodium also occurs in juice but to a much smaller extent, Honig (5) putting the ratio K: Na in mixed juices at about 7 : 1 on a weight basis.

The potassium accounts for about one-half of the total cations present in juice.

According to Honig (6) and Saint (7) the degree of extraction of potash is close to that for sucrose in that approximately 93 per cent of the K_2O in the whole cane is present in the juice.

It is evident therefore that the K_2O content of the juice is a good indication of the quantity in the cane, this fact being used formerly to calculate the rate of depletion of the soil by the crop. Using the K_2O content of the juice as basis, the data of the rate of depletion of the soil was then used as a basis for drawing up the fertilizer programme.

The only factor, however, which should be taken into consideration in determining the rate of application of a fertilizer is whether or not the cane in any one field would give a response in yield of sucrose if the nutrient in question were applied, in other words if the soil is deficient.

Following a wider appreciation of this opinion it was natural that attempts to use the potash analysis of juice as a measure of the available potash in the soil should be made.

It is seen from fig. 10 that for any one variety grown under conditions of normal fertility the potash content of the juice varies by up to 300%, the minimum level encountered being 265 and the maximum 1050 mg/litre of juice, and this on land which is known to give no response when fertilizer potash is applied. As it is not acute deficiencies that are of interest in Mauritius, but the detection of conditions which border closely to the almost normal, then it is reasonable to discount the theory that K_2O of juice has special diagnostic value under our conditions. That the stalk

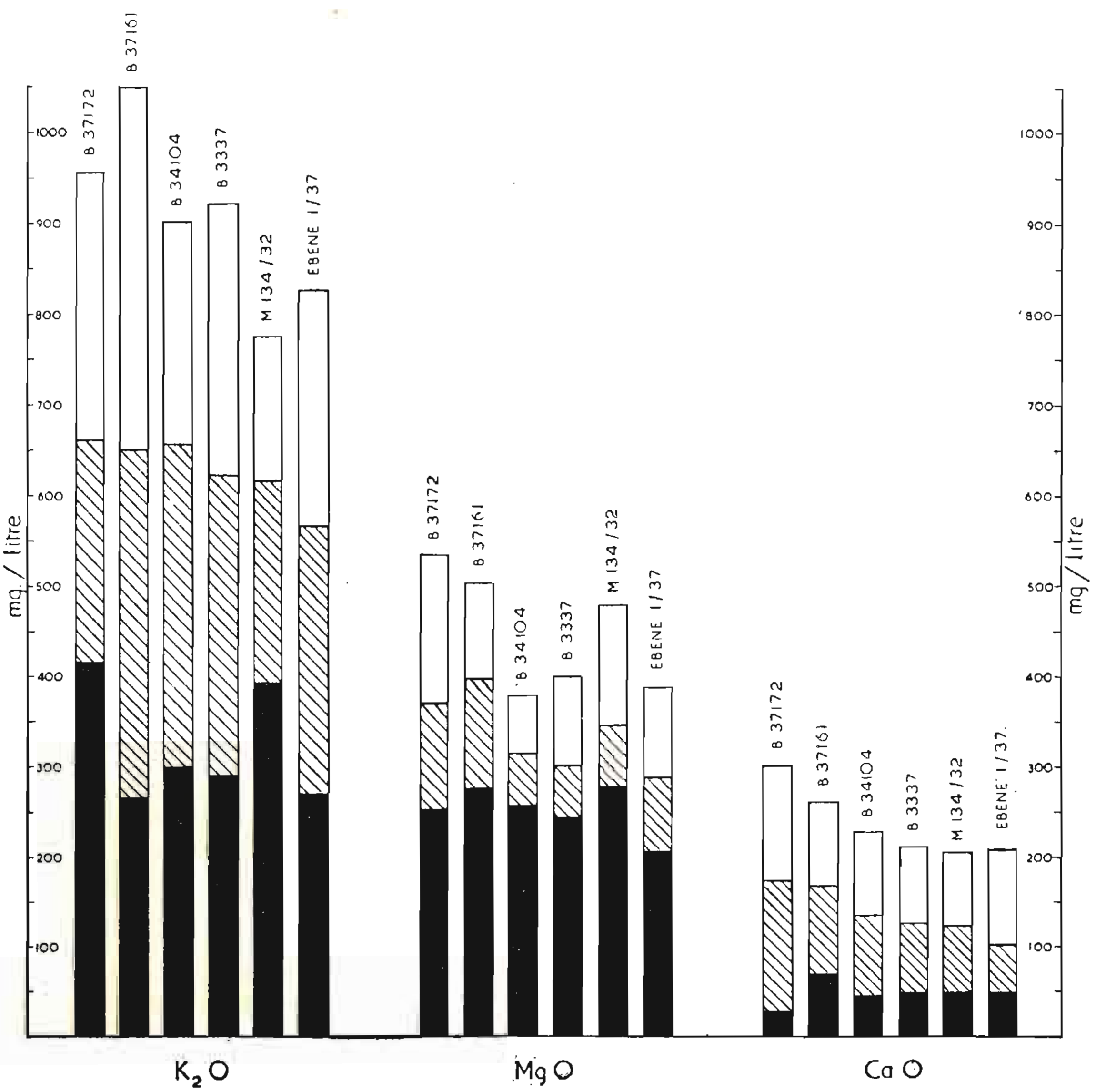

Fig. 10. Maximum, mean and minimum levels of K_2O, MgO and CaO occurring in the juice of six cane varieties.

of the cane acts as a reservoir for potassium is well known and this accounts for the large variations in the potash content of juice from plants which are adequately supplied with the mineral.

From fig. 10, which gives the maximum, mean and minimum levels of K_2O occurring in the varieties tested, it can be seen that the variety B. 37172 gives the highest average value for potash content of juice and Ebene 1/37 the lowest figure, although the range for Ebene is wider than that for B. 37172.

The average composition of all varieties as influenced by the time of harvest, level of nitrogenous fertilization and rainfall is given in table 8.

The effects of increasing the level of nitrogenous fertilization are different for the two rainfall areas, the K_2O falling quite markedly with increasing nitrogen applied in the sub-humid district, but not in the case of the super-humid district.

It is generally accepted that nitrogen fertilization depresses the level of K_2O in juice, but the samples from the super-humid zone did not show the depressive effect.

From table 11 it is seen that only in the case of the sub-humid plots was a yield increase obtained with additional nitrogen and it would seem from these results, therefore, that increasing the rate of nitrogenous fertilization depresses the level of K_2O in the juice only when the extra nitrogen brings about an increase in yield.

Table 8. Effect of different levels of N and time of harvest on K_2O content of juice (mg/litre).

Nitrogen applied	Sub humid zone	Super-humid zone	Date of harvest	Sub-humid zone	Super-humid zone
20 kgs/arp.	720	573	July	776	787
40 ,, ,,	712	562	September	690	543
60 ,, ,,	634	562	November	601	367

The figures for the percentage Brix showed no constant differences between the various nitrogen treatments. The effect of lateness of harvest, however, was to cause an increase in the percentage Brix figure and therefore if the K_2O figures (mg/litre of juice) were recalculated to K_2O % Brix solids, the fall in potassium with the later harvest dates would be even more marked than the fall that occurs in K_2O content of the juice.

The effect of rainfall is shown by the generally higher levels of potash in cane from the sub-humid district, the mean figure for the dry district being 689 and for the wet district 566 mg/litre.

These figures reflect the generally lower levels of bases in the highly leached soils. It must be stressed again, however, that potassium was not a limiting factor to growth as can be seen from the figures for foliar levels of potash which are normal (table 11)

Calcium and Magnesium

Calcium and magnesium are present in appreciable quantities in mixed juice, the ratio of the two varying somewhat according to extraction conditions, magnesium being more easily extracted from the cane, by usual milling technique, than calcium.

Honig (loc. cit.) states that the ratio of alkaline earths to alkalies is related to the analysis of the soils upon which the cane is grown, the relationship being that, if the exchangeable potassium and sodium in the soils are high in proportion to the amounts of exchangeable calcium and magnesium, the same relationship is found in the cationic composition of mixed juice.

In fig. 10 the ranges and average contents of calcium and magnesium in juice are shown.

The calcium and magnesium figures for any one variety are closely correlated, B. 37161 and B. 37172 being uniformly high in Ca and Mg, and Ebene 1/37 being low in both. The figures for potassium also gave B. 37172 a high and Ebene 1/37 a low rating amongst varieties, thus showing a strong varietal effect on the level of the alkali and alkaline earths metals occurring in juices.

From table 9 it is seen that the differences between the various treatments are small and cannot be accepted as indicating definite trends, although the influence of rainfall is again seen, canes from the high rainfall districts containing slightly less Ca and Mg in their juices.

Table 9. Effect of different levels of N and time of harvest on calcium & magnesium content of juice (mg/litre)

Nitrogen applied Kgs/arp.	Sub-humid zone		Super-humid zone		Date of harvest	Sub-humid zone		Super-humid zone	
	CaO	MgO	CaO	MgO		CaO	MgO	CaO	MgO
20	136	338	131	314	July	135	305	134	320
40	146	350	127	323	September	126	355	100	329
60	168	371	129	330	October	190	399	153	321

Phosphorus

The analysis of juice for phosphate content is usually divided into "inorganic phosphate" determined directly on the diluted juice and "total phosphate" determined after oxidation of the organic matter present in the juice.

The term "inorganic phosphate" is rather a loose one as it is known [Honig (5)] that the figure is usually higher than corresponds with the P_2O_5 solubility for calcium and magnesium phosphates in sucrose solutions, this discrepancy being due probably to the inclusion of hexose phosphate in the inorganic figure.

In this work, therefore, only the figures for total phosphate are given as, apart from its analytical limitations, the inorganic phosphate figures vary erratically from about a fifth up to almost one half of the total phosphate figure.

The results for varieties are given in fig. 11 and show that differences between varieties are small although once again B. 37172 gives a higher mean level that the other varieties. The work of Craig (8) using the varieties White Tanna, R.P. 8 and R.P. 73 showed a very strong varietal influence, the White Tanna averaging twice the P_2O_5 content of R.P. 8 and four times that of R.P. 73.

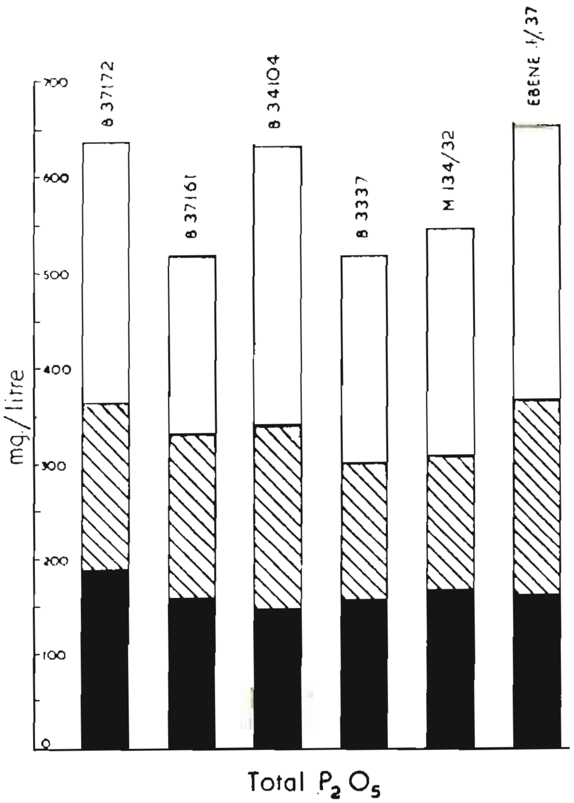

Fig. 11. Maximum, mean and minimum levels of P_2O_5 occurring in the juice of six cane varieties.

The influence of time of harvest and rainfall regime is shown in table 10.

The later cut cane shows an increase in phosphate content whilst it was found that under identical conditions the potassium content fell with advancing harvest dates.

The effect of high rainfall is again seen, in that the average P_2O_5 for the sub-humid district is 401 and for the super-humid district 254 mg/litre, phosphate, however in neither case being a limiting factor to growth.

It is worthy of note that only one batch of samples from the high rainfall area gave a figure approaching the level of 350 mg. P_2O_5 usually accepted as the minimum for efficient clarification, whilst most of the samples from the low rainfall district were above this figure.

Table 10. Effect of time of harvest on total P_2O_5 content of juice (mg/litre).

Date of Harvest	Sub-humid zone	Super-humid zone
July	289	229
September	388	176
November	526	358

The influence of nitrogen fertilization on the phosphate content of juice (mean of six varieties) is shown in table 11 together with yield of sugar in tons C. C. S. per arpent.

The foliar diagnosis figures for N, P_2O_5 and K_2O obtained from the Agronomist of the Institute are also given.

Table 11. Effect of different levels of N on P_2O_5 content of juice (mg/litre), yield of commercial sugar and foliar diagnosis.

Climatic Zone	Sub-humid			Super humid		
Level of Nitrogen in Kgs/arpent	20 N	40 N	60 N	20 N	40 N	60 N
Total P_2O_5 mg/litre	471	380	349	250	262	252
Tons C. C. S. per arpent	4.56	4.94	5.13	4.18	4.18	4.09
Foliar N	1.54	1.71	1.77	2.00	2.05	2.16
Foliar P_2O_5	0.50	0.50	0.49	0.49	0.50	0.51
Foliar K_2O	1.29	1.33	1.27	1.33	1.28	1.28

From the foliar diagnosis figures it is seen that:

(a) N is below the optimun level and increases with increasing application of nitrogen in the low rainfall samples whilst in the high rainfall samples N is optimal.

(b) That all figures for P_2O_5 and K_2O are about optimal.

The figures for total P_2O_5 show a marked decline with increasing application of nitrogen, when that nitrogen is effectively used by the crop in producing higher yields. In the high rainfall experiment no increases in yield resulted from nitrogen application and the total $P\ O_5$ in the juices remained at same level.

The observations made in the section on potash content on the use of nutrient level in juice for forecasting the need for fertilization apply equally to phosphorus. The variability of the phosphorus in juice is of the order of 200% and it is also seen that the level of P_2O_5 is profoundly influenced by factors other than the capacity of the soil to provide phosphorus to the growing cane.

SUMMARY AND CONCLUSIONS

The results of the mineral analyses of the juice of six cane varieties grown under different conditions of fertility and climate are given.

For K_2O, MgO, and CaO a strong varietal effect was found; for P_2O_5, however, the varietal effect appears to be weak with the varieties tested.

The generally lower status of juices from high rainfall areas in all minerals has been noted.

From the results obtained it would appear that the effect of increasing nitrogenous fertilization on the K_2O and P_2O_5 contents of juice is governed by whether or not an increase in yield occurs. With an increase in yield both K_2O and P_2O_5 decrease but when no increase in yield is obtained the K_2O and P_2O_5 levels of the juice remain approximately constant irrespective of the amount of nitrogen applied to the crop.

The results presented appear to be of sufficient interest to warrant an extension of this work.

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2. CHEMICAL FERTILIZATION

D. H. PARISH AND S. M. FEILLAFÉ

NITROGEN

For a long time ammonium sulphate has been the most popular nitrogenous fertilizer available in Mauritius, but with the advent of other cheap forms of nitrogen its popularity will decline, provided that the newer fertilizers are as efficient as it is in producing yield increments. Amongst the newer fertilizers imported in bulk into Mauritius is urea.

This fertilizer has caused some misgivings because it contains small quantities of biuret, a material which has proved detrimental to the yield of certain plants (1).

In 1956, therefore, the Chemistry Division laid down field experiments to compare ammonium sulphate and urea as sources of nitrogen; at the same time, pot experiments were planted to test the toxicity of biuret to sugar cane.

Preliminary results from the pot experiments seem to indicate that biuret may be toxic to cane, but only when applied in quantities far in excess of the amount which would be applied to a crop in practice.

In an interesting article by Rotini (2) the known toxic effects of the biuret that may be contained in urea are discussed. Rotini points out, however, that ammonium cyanate, a far more phytotoxic agent than biuret, is formed from urea when this fertilizer is applied to soils of low biological activity. Normally the urea is rapidly transformed into ammonium carbonate by the enzyme urease present in quantity in soils of high organic fertility; conceivably however, conditions may occur where the production of ammonium cyanate is such as to be a potential danger to the crop and therefore this aspect of urea fertilization is being examined.

PHOSPHATE

It is known, though not widely appreciated, that about one-third of the area of cane grown on this island suffers from phosphate deficiency, and this despite fairly heavy dressings of phosphatic guano at planting.

As far as the major nutrients are concerned, unbalanced fertilization of cane is exceedingly wasteful in that not only are maximum yields not obtained, but wastage of fertilizers may occur, and it is therefore essential to eliminate both actual and potential deficiencies of phosphate. To this end the Chemistry Division of the Institute is studying many of the problems connected with phosphatic fertilization.

The complexity of the role of phosphorus as a fertilizer and its various ramifications in soil-plant relationships is widely appreciated, but nevertheless opportunity is taken here of putting forward some of the modern ideas held on this subject which are pertinent to fertilizer work in Mauritius, and to use some of the results obtained in 1956 as illustrations.

The efficient use of phosphatic fertilizers depends not only on soil deficiency and crop requirements but also on the factors of rate, time and frequency of application as well as the method of application and the form of fertilizer used. There are thus five variables to be examined before phosphate fertilization can be truly rationalized. These factors all influence phosphorus availability in soils largely by affecting the degree and rate of fixation of the applied phosphorus.

The most efficient use of a fertilizer is attained when the rate of application is such that the ratio of the value of crop increase to fertilizer costs is near the maximum [Stanford & Pierre (3)].

According to another view, less widely accepted, it is held that the phosphorus status of the soil should at once be built up to some desired level, which may be considerably beyond that required for maximum yields. This view is more or less the attitude adopted in Mauritius where supplies of cheap phosphatic guano are readily available.

The beneficial effects of this practice will vary according to the fixing power of the soil and it is of interest to note that Williams (4) has found that an application of 2500 pounds of 20 per cent superphosphate was unable, a year later, to fully supply the phosphorus requirements of a crop grown on that land. In view of results of this nature the official attitude adopted in Great Britain, where the soils generally have high phosphate fixing powers, is that the frequent or annual application of phosphate, according to the responsiveness of the individual crop, with suitable adjustments for local soils and climatic conditions, is undoubtedly the sounder practice [Stewart (5)].

Another practice which is generally accepted abroad, but which is not followed in Mauritius is that insoluble phosphate should be mixed intimately with the soil, placement of fertilizer usually being reserved for soluble phosphates.

The reason for these practices is that the insoluble phosphate when mixed with the soil is exposed to the solubilizing effects of the soil "acids" whilst "placed" soluble phosphate is protected to some extent from fixation by the soil.

The "form of phosphate" experiments planted in 1954 by the Chemistry Division gave, when harvested as virgins, results of interest which were published last year [Parish, Feillafé, and Rouillard (6)].

The first ratoon results of these experiments have not proved suitable from an interpretative point of view as only two of the experiments responded to phosphate and in these two experiments all the treatments responded to the same extent. This similar response probably is due to the known fact that highly contrasted fertilizer material may give similar yields merely because they have been used at rates high for the conditions tested.

It is essential to have a high degree of sensitivity when testing the efficacy of different phosphatic fertilizers and two conditions are all-important : the soil must be deficient in phosphate and the fertilizer phosphate must be applied at minimal rates so that the comparison of the efficacy of the forms of fertilizer employed can be restricted to the steeply rising portion of the response curve.

Under field conditions this presents some difficulty but it is hoped that these two problems will be overcome by careful selection of sites and by adjusting the level of fertilizer applied.

Apart from the experiments planted to test the efficacy of different forms of phosphate, five experiments were laid down in 1954 and 1955 on second ratoons with the object of testing the efficacy of phosphatic guano and superphosphate in overcoming phosphate deficiency in ratoon crops, when applied either directly on the stools or on the trash in the interlines.

The results are given in table 12 together with the levels of foliar P_2O_5.

Once again the results show the difficulty which has been met in finding places deficient in phosphate. These two experiments, however, have given results of interest in that they show that a highly significant response follows the application of phosphate to the ratoon crops. The response when the phosphate is applied on trash is superior to surface application and superphosphate, in the case of the La Sourdine experiment, significantly outyields phosphatic guano. The experiments were harvested again a year later in third ratoons, but no responses were obtained, and it would seem, therefore, that residual responses from phosphate application are low, a result which was also indicated in the "form of phosphate" experiments.

In the latter experiments this lack of residual value could be due to either the high fixation of added phosphate by local soils, or to the fact that the virgin crop may suffer from phosphate deficiency, but the following ratoon crop, due to a far greater ramification of the root system, is able to obtain sufficient phosphorus from the soil to meet its needs.

The trash layer in the interrows acts as a mulch in the drier districts and in the wet districts it is continually moist and in an active state of decomposition. Under these conditions the roots of the cane grow to the surface of the soil and this may account for the observation that the phosphate placed on the trash appears to be more available to the cane than the same phosphate applied directly to the soil.

In view of the different responses to the two methods of placement it is interesting to note the results obtained by Humbert (7) in Hawaii using radioactive phosphorus as a marker.

In Hawaii the methods of application are dependent primarily upon the kinds and amounts of fertilizer used. The majority of Hawaiian soils have the capacity to fix phosphorus effectively

Table 12. Results of Phosphate Placement Experiments.

Treatment / Locality	Yield in tons cane/arpent: Control	Superphosphate surface application	Superphosphate applied on trash	Phosphatic guano surface application	Phosphatic guano applied on trash	Foliar diagnosis: P_2O_5 index: Control	Superphosphate surface application	Superphosphate applied on trash	Phosphatic guano surface application	Phosphatic guano applied on trash
La Sourdine	30.8	34.3*	35.9‡	30.8	29.6	0.42	0.44	0.48	0.45	0.41
Haute Rive	42.5	43.2	47.7‡	39.2	45.8	0.44	0.49	0.50	0.50	0.50
Vallombreuse	38.5	38.5	43.5	41.2	36.8	0.45	0.50	0.50	0.49	0.48
Hermitage	28.6	29.0	27.9	26.7	28.5	0.50	0.49	0.47	0.48	0.49
New Grove	16.1	16.7	17.6	14.6	16.5	0.46	0.48	0.46	0.45	0.46

* *Significant at 5% level*

‡ " " *1%* "

so that placement of soluble phosphate fertilizer becomes important. Placement studies with radioactive phosporus which were conducted from 1950 onwards have shown the optimum position to be beneath the seed piece, where the highest percentage of roots will have access to the fertilizers. All shoots of all stools are radioactive with this placement when radioactive phosphate is admixed with the fertilizer applied. Phosphate placed in subsurface position 10 to 12 inches from the centre of the stool resulted in a low efficiency of uptake, only about one-third of the shoots of the stool becoming radioactive. When placed in subsurface positions midway between the lines, five feet apart, less than 5 o/o of the shoots obtained phosphorus from the fertilizer. These studies included tests with both virgin and ratoon crops and the results were interpreted as indicating a low efficiency of the root system of the preceding plant crop in feeding the successive ratoon crop.

Other placement studies with radioactive phosphate fertilizers carried out by Humbert compared surface placement on the cane line with subsurface placements 4 to 6 inches deep and 10 to 12 inches from the centre of the stools. In the more humid areas where the soil is continually moist, the roots grow to the surface and are able to use the phosphorus applied to the soil surface. This was found to be particularly true when the soil was covered by a blanket of trash from the preceding harvest, result which is borne out by those obtained locally. Under irrigated conditions, where the soil is alternately wet and dry, roots do not grow to the surface and hence are unable to use surface-applied phophate as effectively as when it is placed in subsurface positions near the stool.

Apart from these very interesting observations of Humbert it is seen that radioactive tracer work provides a means of obtaining information about soil and fertilizer phosphorus extremely quickly and this type of work has now become an essential adjunct to field trials. The possibilities of carrying out similar work in Mauritius are being examined.

Although further work still needs to be carried out before final conclusions can be drawn, it would appear, from results obtained locally and in other parts of the world, that annual applications of smaller doses of soluble phosphate might be more beneficial.

LIME APPLICATIONS

In the 1954 Annual Report of this Institute, Feillafé presented the results of a series of experiments laid down to test the possibility of a yield response to calcium and magnesium applications.

The results given showed that in the gravelly soils of the super-humid districts a significant increase in yield followed the application of two tons of lime per arpent at planting.

The reasons for this beneficial effect are not obvious as the calcium levels of these soils and of the canes grown on them do not indicate that calcium is a limiting factor. The results [Parish & Feillafé (8)] of pH studies showed that the pH was increased by only 0.4 units on liming, a negligible increase, as sugarcane is a crop which is extremely tolerant to soil acidity.

It has been suggested that the response may be due to increased availability of molybdenum which is known to increase with increasing soil pH, but if this element is a limiting factor to cane growth, the slight changes of pH recorded and the fact that the soils are still acid would militate against this suggestion. Added to this is the fact that total molybdenum content of all Mauritius soils is fairly constant at about 0.5 ppm.

The possibility that the effect of lime application was due to a stimulation of the growth of micro-organisms present in the soil must be considered and to this end samples of soils from the limed and unlimed plots were analysed in Madagascar† according to the usual scheme employed there.

The results were not conclusive, and as the nitrogen fixing organism present in tropical soils, *Azotobacter indicum*, shows maximum growth at pH 6.2 [Moureaux (9)] it would be expected that both free and gravelly soils would respond in the same way when they were raised to this pH as occurred in these lime trials. There was no change in the level of foliar nitrogen as a result of lime treatment and it thus seems improbable that nitrogen fixation is a factor controlling growth differences.

TRACE ELEMENTS

Great interest has always been shown in the use of "trace" elements for agricultural purposes.

Most frequently the recovery of a crop from a state of acute trace element deficiency has been spectacular and this in many ways has led to the popular interest in these plant micro-nutrients.

Concerning sugarcane, however, only a few instances of noticeable response following trace element applications have occurred and these have been on soils which obviously presented special problems. Thus the work on the trace element nutrition of sugar cane which gave the most spectacular results was carried out on the peat soils of Florida. There, copper was found to be a limiting factor and Bourne (10) found that the application of 20 lb. per acre of copper sulphate gave an enormous stimulation to the crop. This discovery led to the rapid expansion of the sugar industry in that area. Deficiency of zinc has also been shown to limit cane yields in Florida and it is common practice to apply 4½ lb. of zinc sulphate along with the copper sulphate at planting.

Copper deficiency has also been described in Queensland and recently in South Africa [Du Toit (11)] whilst Evans (12) in British Guiana has found that deficiencies of boron, copper and molybdenum may occur in some cane lands.

Interest in the possible deficiency of trace elements in soils has always been shown locally, though it is unlikely that any deficiencies do exist which would give a spectacular response to micro-nutrient application; nevertheless there is the feeling that border line deficiencies may occur.

This possibility is being tested on Rose Belle sugar estate where trace element trials with low and high N P K fertilization have been laid down.

Samples of soils have also been collected from various localities and forwarded to the United Kingdom for analysis. Some of the results are given in table 13.

† Analyses carried out by Mr. Moureaux, I.R.S.M., Tzimbazaza, Tananarive, Madagascar.

*Table 13. Results of trace elements analysis of some local soils.**

Locality	Maturity	Rainfall Classification	Exchange-able MgO.	Available† Mn.	Available† Zn.	Total Cu.	Total Mo.
Richelieu	Mature	Subhumid	900	18.8	84	52	0.50
Réduit	,,	Humid	690	28.7	10	61	0.50
Belle Rive	,,	Superhumid	160	8.7	5	52	0.75
Union Park	Immature	,,	221	7.5	5	56	0.75
Bois Chéri	,,	,,	139	17.3	15	70	0.50

* *We are indebted to Mr. J. B. E. Patterson of Bristol for these analyses.*

† *The 'available' level of a nutrient is that amount which is soluble in 2% acetic acid according to the method of R. L. Mitchell, Macaulay Institute.*

It is impossible at this stage to give any diagnostic interpretation to these data; nevertheless they are of interest in demonstrating the large differences which occur between different localities and in illustrating the diminution in the status of potential plant nutrients with increasing rainfall.

The low levels of available zinc in the Belle Rive and Union Park samples are worthy of note, although so far as our experience goes, no local case of zinc deficiency in cane has yet been demonstrated.

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3. TITRATION CURVES OF SOME LOCAL SOILS

D. H. PARISH AND S. M. FEILLAFÉ

The rocks of Mauritius are entirely volcanic in origin and may be classified as follows:

1. Older Volcanic Series

2. Younger Volcanic Series { Early Lavas / Late Lavas

The Older Volcanic Series is responsible for the more rugged and mountainous features of the landscape and these are thought to represent the worn down summit of an immense shield volcano.

Prolonged erosion of the Older Volcanic Series was terminated by a renewed outburst of volcanic activity which flooded the old topography with a great thickness of lava giving rise to the essential features of the present day landscape.

The Younger Volcanic Series is subdivided into the Early Lavas, which are confined to the south western part of the island, and the Late Lavas which cover about 70 percent of the present day land surface [Simpson (1)].

The Late Lavas are described by Simpson as being doleritic basalts of remarkably uniform character.

However, considerable variations in the physical characters of these recent lava flows occur; in some areas they are compact, whilst in others more often vesiculated or even scoriaceous. This variation in the physical character of these flows is obviously extremely important from a pedological point of view as under the same climatic conditions a crumbled highly vesicular lava will weather differently from the compact blocks of lava.

These Late Lavas of the Younger Series are the parent material of the agricultural soils of Mauritius.

The climate of Mauritius is governed by three different factors:

(a) the position of the island in latitude 20° South

(b) its insular position in the Indian Ocean and

(c) the effect of varying elevation and topography.

This latter factor is influenced by differences of exposure to the prevailing south east trade winds resulting in a high rainfall which increases with elevation on the windward side and in a very low one on the leeward side of the island. The normal distribution of rainfall therefore varies from 30″ per annum on the leeward coastal plain to up to 200″ on the high plateau, thus giving a great variety of microclimates. The mean annual temperature of the low rainfall area is 24° C, this temperature falling to 20° C on the upland plateau.

Thus it may be said that the microclimates of Mauritius as those of the Hawaiian Islands are largely induced on an oceanic base by the orographic effects of local physiographic features.

The influence of these microclimates, each with its own amounts and distribution of rainfall, cloudiness, temperature and moisture resulting from the effects of slope and elevation on soil development, are paramount, particularly in view of the uniform nature of the parent rock.

These effects of local climate on the processes of soil formation have been recognized by Craig and Halais (2). Halais (3) has classified broadly the soils occurring on the Late Lavas as is shown in table 14 and thus has correlated three distinct climatic zones with the soils occurring in each of these zones.

In addition, Halais recognizes one other soil, the Plaine Lauzun heavy clay occurring as slope alluvium in the sub-humid area.

The climate and geological history of the Hawaiian Islands are very similar to those of Mauritius and it is natural therefore to expect some degree of relationship between local soils and the soils of Hawaii.

In the soil survey of Hawaii carried out by Cline et al. (4) and recently published, a tentative system of great soil group classification for tropical soils has been used.

Table 14. Principal Soil Types of Mauritius.

Parent material / Climatic zone & elevation	Mature deep soil: Lateritic weathering material from smooth doleritic basalts		Immature shallow soil: Lateritic weathering from vesicular lava flows
Sub-humid 30-50″ rain per annum. 0-300′ altitude	RICHELIEU bouldery clay SiO_2/R_2O_3 = 1.7	← age —	MAPOU gravelly clay loam SiO_2/R_2O_3 = 1.7
Humid 50-100″ rain per annum. 0-1200′ altitude	REDUIT bouldery clay SiO_2/R_2O_3 = 0.95	← age —	PLAISANCE gravelly clay loam SiO_2/R_2O^3 = 1.3
Super-humid >100″ rain per annum. 300–1500′ altitude	SANS SOUCI bouldery clay loam SiO_2/R_2O_3 = 0.35	← age —	ROSE BELLE gravelly clay loam SiO_2/R_2O_3 = 0.65

This system, however, has not yet been widely accepted, for as Cline points out, much work must be done on tropical soils before the great soil groups which he has proposed can be defined specifically and that the groups given may be either finally recognized or in some instances, further subdivided.

In view of similarities which exist between the climates and parent rock of Mauritius and Hawaii a comparison of local soils and those classified by Cline must be made. As much research is carried out in Hawaii particularly for the sugar industry the comparison of the soils of the two countries becomes even more essential as it may enable the rational application of the results of Hawaiian research to local conditions.

Matsusaka and Sherman (5) have published some interesting information on the buffering capacities of Hawaiian soils, work which showed that each of the great soil groups has a characteristic titration curve.

The titration curves of some local soils have been determined and are presented here, the similarities to or differences from the Hawaiian soils being also discussed.

RESULTS AND DISCUSSION

The titration curves of five local soils were determined using the method described by Matsusaka and Sherman (loc. cit.)

The curves given in fig. 12, are for a typical Hawaiian Low Humic Latosol and for the Richelieu and Sans Souci soils of Halais.

The general shape of the curves is the same, the increase in buffering capacity from the Low Humic Latosol to the Richelieu and and Sans Souci soils being due probably to variations in the organic matter content of these soils.

The description of a typical Low Humic Latosol given by Matsusaka and Sherman is as follows:

"The soils of low humic latosols are found at low elevations, usually from sea level to 1,500 feet. They are developed under a rainfall ranging from 15 to 80 inches per year. The A horizon of the soil profile is weak and

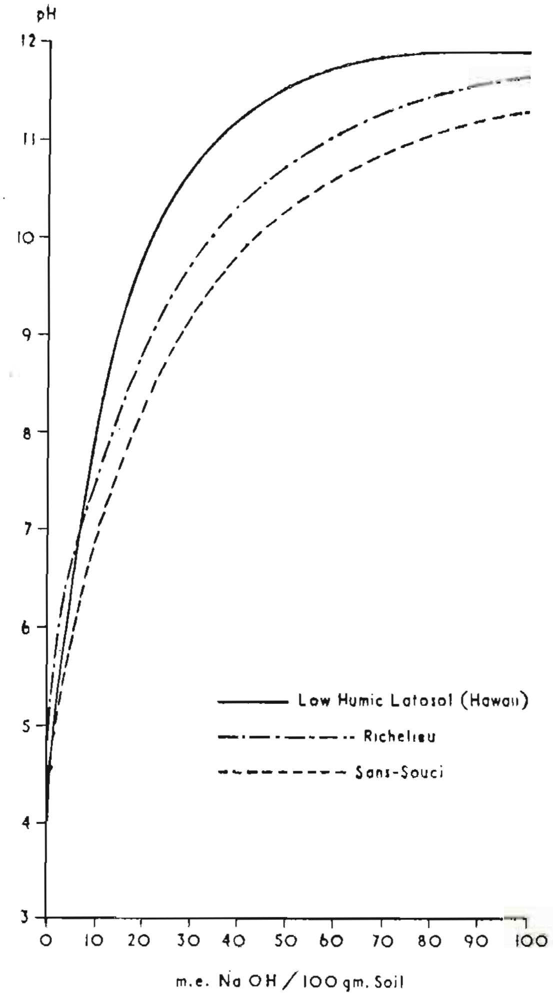

Fig. 12 Titration curves of two local soils of the latosol suborder compared to the low humic latosol group of Hawaii.

shallow, usually less than a foot in thickness. The B horizon is from 2 to 3 feet thick and grades gradually into the C horizon. These soils have a high clay content 50 percent or more, but have the physical properties of a silty clay loam. The dominant clay mineral of this group has been identified as the kaolinite type.

The chemical analysis of a typical soil of the low humic latosol shows that the soil solum has a very high content of both iron and aluminium oxides. The silica-sesquioxide ratio is low, ranging from 1.2 to 1.8. One of the distinguishing characteristics of the low humic latosol is its high manganese content. The cation exchange capacity of these soils is low, ranging from 15 to 30 milliequivalents per 100 gm. The soil reaction of the virgin soils ranges from pH 6.0 to 7.5. They have a low organic matter content as compared to other Hawaiian soils, the usual range being 2.5 to 4.0 percent."

The description fits very closely to that of the Richelieu soil, but the Sans Souci soil is quite different although the titration curve fits more closely in shape to the low Humic Latosol curve than to any of the other curves given by Matsusaka and Sherman.

The curves for the dark magnesium clays (fig. 13) show the similarity between the Hawaiian and Mauritian soil of this nature. These curves give the typical inflexion of montmorillonitic clay as distinct from the smooth curves obtained in fig. 12 with soils containing kaolinitic clay fractions.

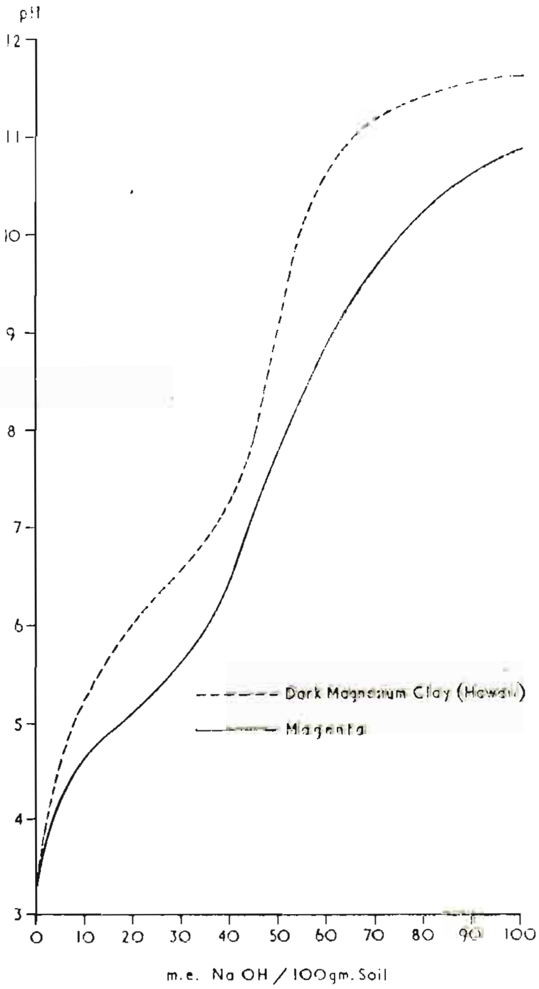

Fig. 13. Titration curve of the dark magnesium clay of Hawaii and that of a local soil of the same nature.

The description of the dark magnesium clays given in the Hawaiian soil survey (4) fits closely to the local soils of this group.

The curves in fig. 14 are for two gravelly soils, the Mapou and the Rose Belle soils of Halais. The Mapou curve shows an inflexion which seems to indicate a content of montmorillonitic clay. These soils occur in the sub-humid area and under these conditions synthesis of montmorillonite seems to occur, although the soils are extremely free draining because of their gravelly nature. The Rose Belle soil, on the other hand, gives the smooth curve associated with kaolinitic clay fraction. As these soils are highly leached and are undergoing intense weathering the formation of kaolinitic clay is to be expected.

The stony soils in Hawaii have been bulked together in the survey carried out there as lithosols and no chemical data are available for these soils.

It is of interest to note that whilst the gravelly soils of Mauritius are an integral part of the sugar growing economy of the island the equivalent soils in Hawaii which were at one time under cane have been abandoned due to the increasing cost of labour and the difficulty of mechanization of this type of land.

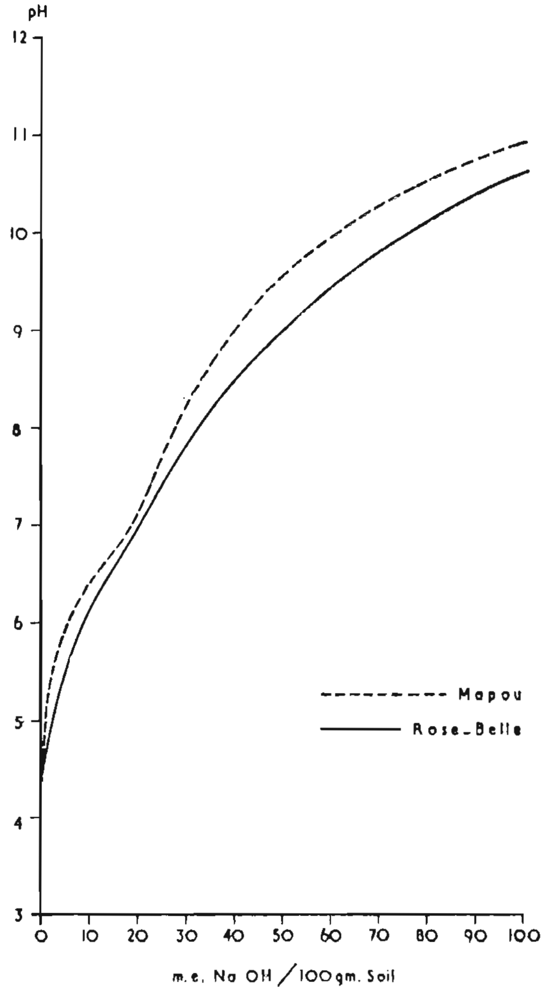

Fig. 14. Titration curves of two immature local soils.

SUMMARY

The geology and climate of Mauritius are briefly described. The necessity of correlating local soils with those occurring in Hawaii is stressed.

The titration curves of some local soils are given and comparison between these soils and the soils of Hawaii are made.

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4. FOLIAR DIAGNOSIS

PIERRE HALAIS

The year 1956 has ended the first decade of organized control of the nutrition of sugar cane fields by means of foliar diagnosis run on an industry-wide basis. Leaf sampling and chemical analyses, mainly for P and K, have been carried out systematically on cane growing in numerous fields over the majority of sugar cane plantations of the Island.

It is gratifying to note that recent research made by Innes and Chinloy (1) in Jamaica and by Evans (2) in British Guiana has confirmed the optimum ranges for P and K nutrition as set earlier in Mauritius (0.45 — 0 55 for P_2O_5 % d.m., and 1.35 — 1.65, for K_2O % d.m.), where the 3rd leaf-punch technique originated.

Three years running averages showing the proportion of deficient cases still occurring in fields on individual sub-section of large plantations are providing reliable data for following variations in nutritional status. It cannot be stressed too often that the diagnosis is of real value, only if it truly represents the mean level of cane nutrition, a condition which is obtained after a few years of repeated sampling and analyses so as to cope with the vagaries of atmospheric conditions.

The accumulated data have contributed to the following conclusions of local interest:

(1) The present P and K status of cane nutrition, as revealed by foliar diagnosis, may vary widely from one sugar plantation to another as a result of different management and fertilizer practices followed in the past. Soil type and climate have only played a minor part in this connection within the natural limits where they occur in Mauritius.

(2) The high colloidal content of local soils prevent P and K fertilizers applied as surface or sub-surface dressings to migrate towards the active absorbing root system of the cane. The best opportunity normally offered for placement of the large doses of fertilizer required to correct a known deficiency, specially phosphates, under the permanent reach of cane roots is at planting time when the furrow is wide open. But the present practice of long ratooning places this opportunity at some eight to ten years intervals. Consequently, rapid and durable correction of existing P and K nutrition calls for a resolute effort, both financial and technical, combining larger doses, more adequate forms and better placement of the needed fertilizers.

(3) Nitrogen fertilization is better understood by the cane growers and does not differ much from the prescribed amounts of roughly 1 kg of nitrogen per ton of cane expected for virgins or ratoons, plus an extra fixed amount of 10 kg. N per arpent for the ratoons. Direct foliar diagnosis is not used in this connection, but the differential method now available can find use in cases where conditions widely differ from normal.

Optimum Range for P and K nutrition of six varieties.

The six post-release trials conducted in 1955 and 1956 have allowed the delimitation of optimum ranges suited to each commercial cane variety. As usual, the foliar diagnosis refers to the 3rd. leaf punch technique on ratoons aged 4 to 7 months (table 15).

Table 15. Comparative optimal levels of P_2O_5 and K_2O in the leaf punch of six commercial cane varieties.

Varieties	Optimum Range P_2O_5 % d. m.	Optimum Range K_2O % d.m.
M. 134/32	0.45 — 0.55	1.35 — 1.65
Ebène 1/37	0.39 — 0.47	1.35 — 1.65
B. 3337	0.40 — 0.48	1.20 — 1.50
B. 34104	0.43 — 0.53	1.20 — 1.50
B. 37161	0.40 — 0.48	1.20 — 1.50
B. 37172	0.42 — 0.52	1.20 — 1.50

Comparison between Foliar and Basal Internode Diagnosis.

Two permanent manurial trials, — Chem. 2/47 and Chem. 1/49 — started in 1936 and located at Réduit Experiment Station, were the first to be used, some twenty years ago, to inaugurate foliar diagnosis studies in Mauritius. They have reached the 5th. ratoon stage of their fourth cycle in 1956. Yield differences following manurial treatments have been considerable and it was reasonable to expect corresponding differences in cane nutrition as revealed by foliar and basal internode diagnosis (table 16).

Table 16. Comparative Foliar and Basal Internode Diagnosis of two manurial trials.

Treatment	Nitrogen % d. m.		P_2O_5 % d. m.		K_2O % d. m.		T. C. A.
(Chem 2/47)	F. D.	B. I. D.	F. D.	B. I. D.	F. D.	B. I. D.	
N. P. K.	1.32	0.13	0.44	0.15	1.40	0.30	25.3
N. K.	1.36	0.18	0.38	0.09	1.38	0.28	25.3
N. P.	1.51	0.19	0.51	0.17	0.87	0,21	9.4
(Chem 1/49)							
4N. 4P. 4K.	1.61	0.15	0.46	0.16	1.27	0.40	29.2
N. P. K.	1.28	0.09	0.39	0.16	1.12	0.30	12.7

The first trial shows high potash deficiency and a minor phosphate one; the second trial shows a high nitrogen deficiency and minor phosphate and potash deficiencies

The six post-release trials reaped in 1st. ratoons have also been subjected to comparative studies of foliar and basal internode diagnosis. The summarized results are given in table 17.

Table 17. Effect of different levels of N on Foliar and Basal Internode Diagnosis.

N fertilization in kgs/arpent.	20 N	40 N	60 N
Tons sugar/arpent	4.84	5.13	5.27
F. D. Nitrogen % d.m.	1.74	1.86	1.93
B. I. D. " "	0.17	0.22	0.26
F. D. P_2O_5 % d.m.	0.48	0.48	0.48
B. I. D. " "	0.120	0.100	0.085
F. D. K_2O % d.m.	1.38	1.40	1.37
B. I. D. " "	0.38	0.38	0.40

Basal internode diagnosis of canes in those six post-release trials have been carried out at various ages of the ratoon canes with the following results (table 18).

Table 18. Basal internode diagnosis of 6, 8 and 10 months old ratoon canes.

	6 months	8 months	10 months
N % d.m.	0.210	0.220	0 220
P_2O_5 % d.m.	0.111	0.096	0.099
K_2O % d.m.	0.390	0.380	0.380

The remarkable finding of plant analysis made on these post-release trials is the drop of P_2O_5 in the basal internode following increased absorption of Nitrogen as a result of fertilization.

Four permanent trials, run at the Experiment Stations of the Institute comparing inorganic fertilizers with or without addition of organic factory residues — scums and molasses — have also been subjected to foliar and basal internode diagnosis on the first ratoon crop, and the results are given in table 19.

Table 19. Comparative foliar and basal internode diagnosis of permanent trials comparing inorganic fertilizers to factory residues.

	N % d.m.		P_2O_5 % d.m.		K_2O % d.m.		Tons Sugar/arpent
	F.D	B.I.D	F.D.	B.I.D.	F.D.	B.I.D.	
Inorganic fertilizers	1.94	0.24	0.49	0.10	1.38	0.39	6.40
„ „ +Fact. residues	1.96	0.24	0.50	0.11	1.36	0.45	6.50

It thus appears that the first ratoons show no difference in plant analysis following the use of factory residues.

It is still too early to appreciate the special value of basal internode diagnosis but the method seems to offer information in conjunction with foliar diagnosis when dealing with fertilizer trials.

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Fig. 15. Transmission studies on chlorotic streak at Union Park Experiment Station.

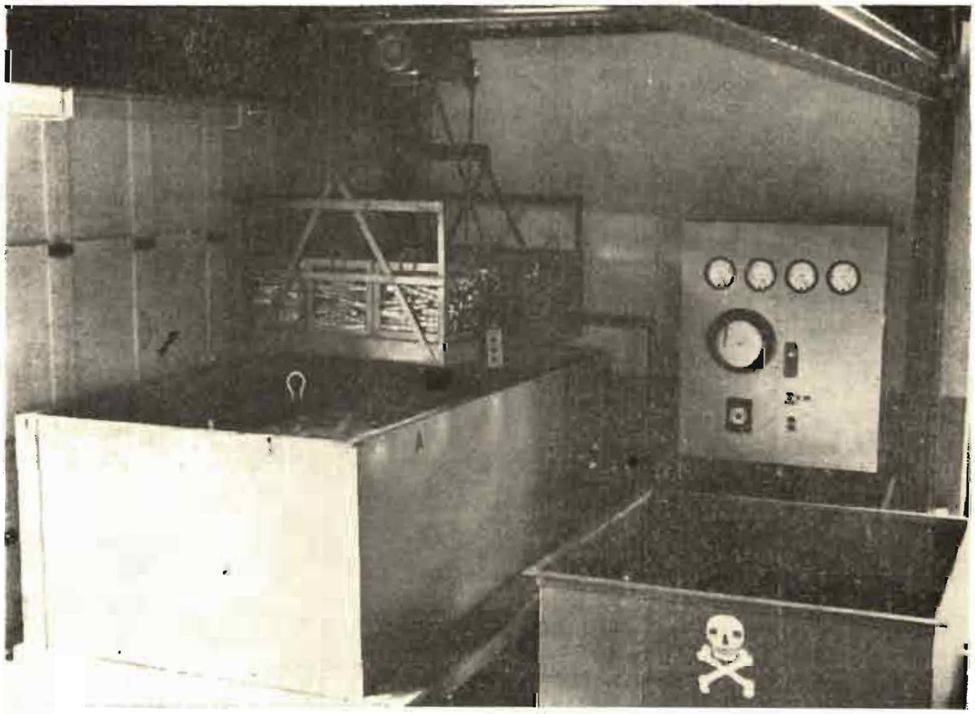


Fig. 16. Experimental hot water tank at Réduit.

CANE DISEASES

R. ANTOINE

1. CHLOROTIC STREAK

CHLOROTIC STREAK is one of the main pathological problems now confronting the sugar industry of Mauritius. The distribution of the disease in the island is well defined. Widespread in the super-humid zone, chlorotic streak is rarely encountered in dry localities except locally on heavy, ill-drained, irrigated soils of the sub-humid area.

The planting of infected cuttings leads to a severe reduction in germination, death of young shoots and early stunted growth and if environmental conditions are favourable to the disease, a reduction in yield with susceptible varieties.

It is generally accepted that the hot water treatment of infected setts at 52° C for 20 minutes destroys the pathogen with the result that the adverse effect on germination and early growth is overcome quite apart from the well known beneficial effect of the heat treatment itself. Yet, in localities where environmental conditions are favourable to the disease, it has been observed that a small proportion of the plants derived from treated setts exhibit typical leaf symptoms of chlorotic streak after some time. The limitations of the heat treatment may be due to several factors:

1. the treatment itself;
2. aerial transmission by vectors;
3. transmission through a soil-borne agent.

It was reported in 1955 that investigations carried out by the Entomologist of the Department of Agriculture in the search for a vector responsible for aerial transmission had given negative results. Experimental work conducted is therefore mainly to try and elucidate the other factors that may be responsible for secondary infection.

(A). INFLUENCE OF TIME OF PLANTING ON RATE OF NATURAL INFECTION.

Two 6 x 6 latin square experiments were established one at Belle Rive, and the other at Union Park both in the super-humid zone where the disease is widespread. The three varieties included are Ebène 1/37, M. 134/32 and B. 3337, canes most commonly grown on the central plateau. The design is such that each block contains three double rows, one for each variety with four stools per row. There were six planting dates, starting in November 1954, and staggered at two-monthly intervals. The planting material consisted of three-eyed cuttings, all hot water treated at 52° C for 20 minutes. Each individual stool was numbered and data on leaf symptoms recorded at monthly intervals. A summary of the results obtained are given in figs. 17, 18 and 19.

Manifestation of symptoms throughout the year are indicated by leaf count as well as shoot count. The two sets of curves for the three varieties are however similar thus indicating that the number of leaves with symptoms per shoot is constant. Rate of natural infection should however be determined by the stool count. A stool is considered infected once leaf symptoms have been recorded in that stool even if they disappear later. The fluctuation in incidence of leaf symptoms makes the stool count the method by which natural infection can be validly assessed. Furthermore, symptoms usually reappear in stools recorded as diseased during the peak period, around the end of the year.

In fig. 17, the rate of natural infection under favourable environmental conditions is given for the three varieties: Ebène 1/37, B. 3337 and M. 134/32, planted in November. It will be noted that the three varieties acquired the disease rapidly under the conditions of the experiment. On the whole about 50% of the stools became infected after 12 months of virgin growth and almost 100% at the end of the first ratoon.

If results expressed in fig. 18, for the same planting date, are compared, it will be observed that there is no correlation between the rate of natural infection and the expression of symptoms. Thus, at the end of virgin growth, although 50% of the stools, on an average, have acquired the disease, the incidence of symptoms is very low. Cuttings selected, at that stage, from apparently healthy stools could well be infected. At the end of the first ratoon however, both stool infection and expression of symptoms are at a high level. It will also be noted that the peak for incidence of leaf symptoms is around the end of the year. That is true for the six planting dates. With the November, January and March plantings there is a small peak towards the end of the first calendar year and a more conspicuous one at the end of the second year. With the May, July and September plantings, there is a small peak at the end of the second year.

In fig. 19 disease incidence is expressed in term of the stool count for the six planting dates. As the curves for the three varieties followed the same trend, they have been averaged into single curves for clarity.

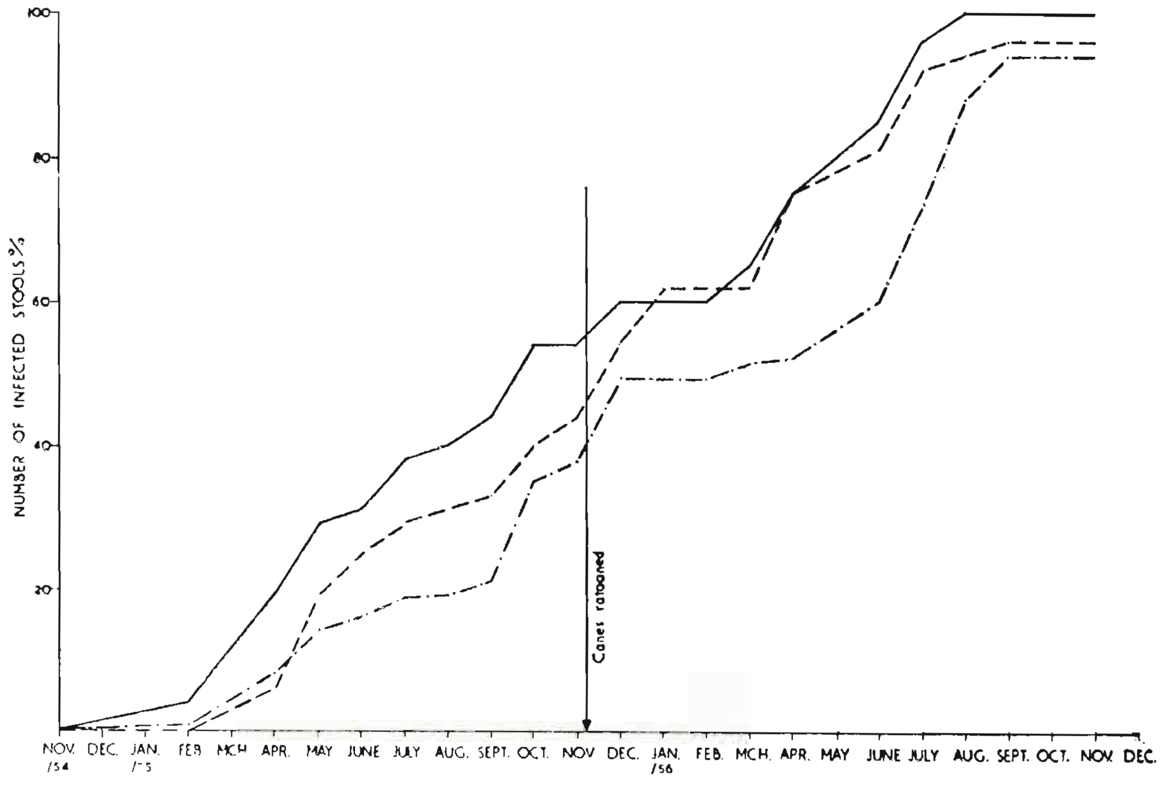


Fig. 17. Rate of natural infection by chlorotic streak as determined by stool counts in three varieties. Plain line: Ebène 1/37, broken line: B. 3337, broken and dots: M. 134/32.

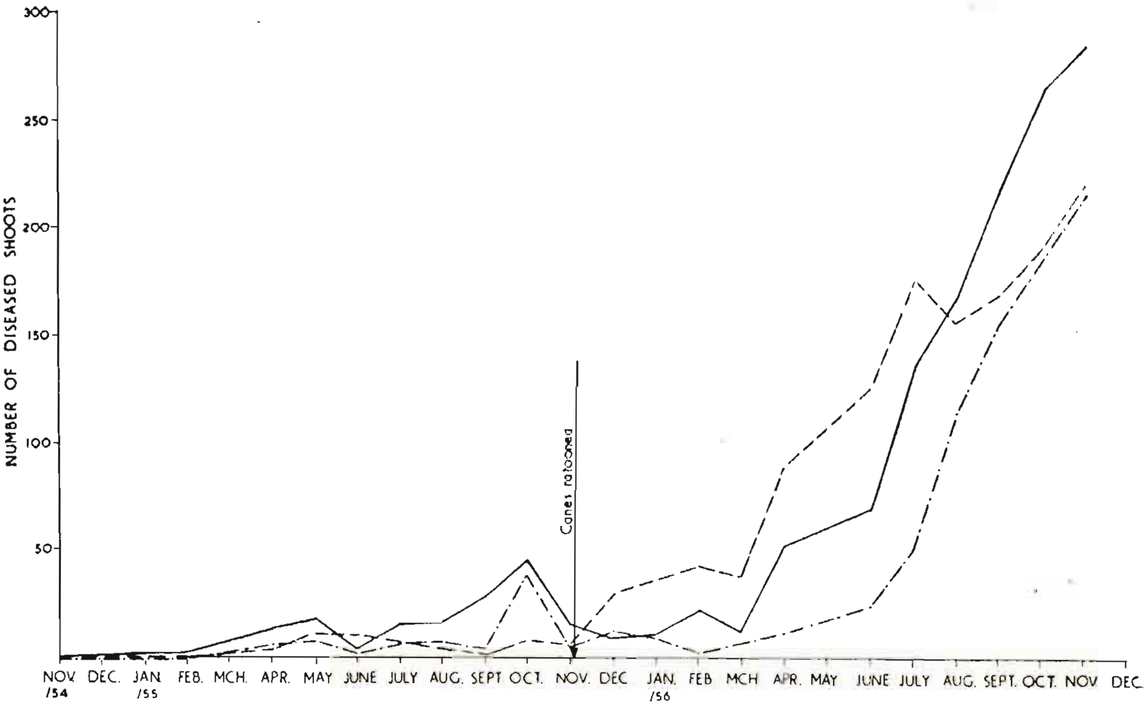
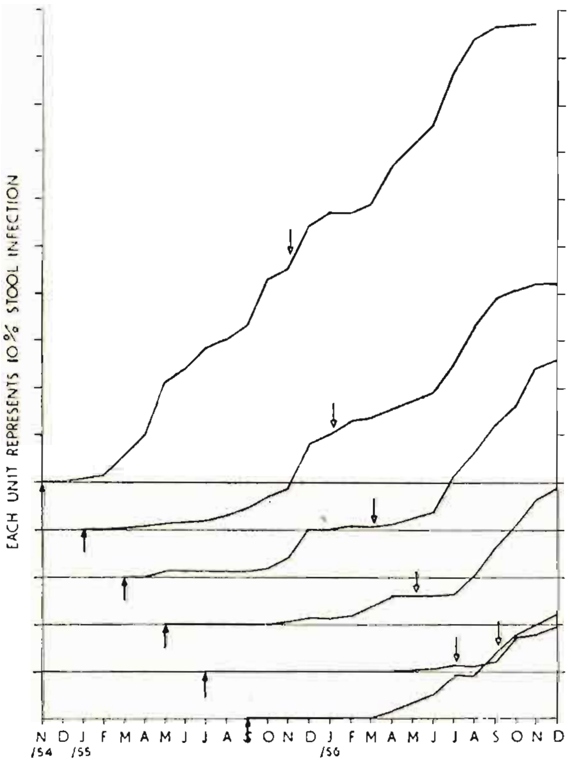


Fig. 18. Rate of natural infection by chlorotic streak as determined by shoot counts in three varieties. Plain line : Ebène 1/37, broken line : B. 3337, broken and dots : M. 134/32.



It will be noted that planting date has an important influence on rate of natural infection, the highest incidence being for the November plantings followed by a gradual decrease to a negligible percentage for the July plantings, then, there is a recrudescence for September (table 20). It would appear therefore that time of planting seems to be a major factor in disease incidence and that consequently plantings, in areas where chlorotic streak prevails, should be properly timed in order to escape the disease at least in virgins and early ratoons.

All the results given above were obtained in the trial established at Belle Rive where abundant symptoms were observed. In the experiment planted at Union Park, a locality where chlorotic streak is normally severe, no symptoms were seen in any plot until the end of 1955. Occasional leaf striping appeared the following year. The very low incidence of symptoms in relation to the absence of an active transmission agent at the experimental site was discussed in the 1955 report.

Fig. 19. Rate of natural infection by chlorotic staeak as determined by stools counts in plantings made at two months intervals.

↑ : Time of planting, ↓ : Time of harvest.

Table 20. Rate of natural infection as influenced by time of planting.

	Stool infection %	
Planting Date	after 12 months	at normal cropping time
November 1954	45.2	45.2
January 1955	20.5	29.0
March 1955	10.4	14.0
May 1955	5.6	6.0
July 1955	1.4	1.4
September 1955	12.8	16.0

(3). INVESTIGATIONS ON THE OCCURENCE OF THE PATHOGEN IN CANES OF DRY LOCALITIES.

Cane in the drier localities of the island do not normally show chlorotic streak symptoms. It may be however that the cane in the apparently disease free area possess the disease in a latent form. To test the above assumption, two trials were established, one at Labourdonnais in the apparently disease-free zone and the other at Belle Rive in the diseased zone. Cuttings of Ebène 1/37 were planted in randomized blocks at the two centres with 10 replications and 3 treatments. Each plot consisted of 2 rows with 20 cuttings. The treatments were:

(i) cuttings originating from canes growing in the diseased zone all showing pronounced leaf symptoms,

(ii) cuttings originating from canes growing in the apparently disease-free zone, all without any leaf symptoms,

(iii) cuttings treated in hot water at 52° C. for 20 minutes before planting.

Preliminary results obtained are given in table 21.

Table 21. Growth failures in two localities in relation to nature of planting material.

Nature of cuttings	germination failures %		Early growth failures %		Total failures %	
	Labourdonnais	Belle Rive	Labourdonnais	Belle Rive	Labourdonnais	Belle Rive
Diseased cuttings	42	80	8	not determined	50	80
Cuttings from apparently disease-free zone	18	32	nil	nil	18	32
Hot water treated cuttings	14	26	nil	nil	14	26

It will be noted that both apparently disease-free and hot water treated cuttings have reacted more or less in the same way as far as growth failures are concerned. It should be stressed that at the two stations the recruiting figure was three times higher in the case of infected cuttings; hence, the importance of giving the hot water treatment to planting material in localities where the disease prevails. Another point that was brought forward in the experiment at Labourdonnais is that in stools originating from diseased cuttings there is a gradual loss of symptoms by the plants. The results are given in table 22 ; they confirm previous findings in pilot experiments laid down with the co-operation of the Entomologist of the Department of Agriculture. In the Belle Rive experiment however all stools originating from diseased cuttings have at all times shown the severe stunting and some leaf striping characteristic of the disease. In both experiments however, plants originating both from hot water treated and apparently disease free cuttings were on the whole three times as tall as those derived from diseased cuttings.

Table 22. Disappearance of leaf symptoms in originally infected stools in a dry locality.

Time after planting (months)	Stools showing symptoms %
6	86
7	73
8	34

Loss of symptoms in stools derived from diseased cuttings planted in a dry locality does not necessarily mean loss of the pathogen. Although preliminary experiments seem to indicate that symptomless cane in the apparently disease-free area do not harbour the disease organism, the findings have to be confirmed and experiments are being carried out to assess also whether loss of symptoms in a dry locality means an actual or apparent disappearance of the disease.

(C). EXPERIMENTS ON THE EFFICACY OF THE HEAT TREATMENT.

In the Labourdonnais and Belle Rive experiments, 4% and 2% respectively of the plants derived from hot water treated cuttings showed leaf symptoms when the first survey was made. That raises the question as to whether the short hot water treatment is 100% curative. Appearance of symptoms in plant derived from hot water treated cuttings could be due to a building up within the sett of the population of the pathogen from the few individuals that may survive the treatment. That important aspect is being investigated in connection with the diameter of treated cuttings. Results obtained so far are given in table 23. The actual temperature reached after 20 minutes at the centre of cuttings during the short hot water treatment has been determined by means of a thermocouple in cuttings of various diameters. It will be noted that with cuttings of Ebène 1/37 a diameter of 4.8 cm. is not of rare occurrence. Heat therapy in relation to diameter of cutting is therefore being studied.

Table 23. Temperatures inside cuttings of various diameters at the end of the short hot water treatment (52°C for 20 minutes).

Diameter of cutting (cms.)	Temperature at centre of cutting after 20 mins.
2.5	52.0
2.6	51.8
2.8	51.5
2.9	51.8
3.0	50.7
3.1	50.9
3.2	50.9
3.3	51.3
3.4	50.0
3.5	49.6
3.6	49.1
4.0	47.6
4.2	48.5
4.8	44.4

(D). SOIL TRANSMISSION STUDIES.

A trial has been established at Union Park in order to investigate whether natural infection takes place in the soil. Diseased cuttings of Ebène 1/37, i.e. cuttings selected from stools showing obvious leaf symptoms and hot water treated cuttings were planted in drums in sterilized and unsterilized soil from an apparently disease-free and a diseased locality. Two cuttings were planted per drum except in the case of diseased cuttings in which three cuttings were planted per drum in order to allow for high mortality. The number was eventually reduced to one established stool in each of the 120 drums, properly randomized. The experiment is illustrated in fig. 15. Almost 100% of the plants derived from diseased cuttings have exhibited leaf symptoms and severe stunting during the first nine months of the experiment. The canes derived from the hot water treated cuttings have been repeatedly observed and so far none has shown any symptom. When the design of the experiment is considered with the drums close together and distributed at random, thus causing an intermingling of diseased and healthy leaves, it should be noted that there has apparently been no aerial transmission. The experiment is being extended and modified in order to study other aspects of disease transmission in the field.

Acquisition of chlorotic streak symptoms is being studied on an area in the super-humid zone, where 25 acres of land which had not borne cane for 35 years, were planted in 1956. Chlorotic streak is widespread in adjoining cane fields. Twenty acres have been planted with cuttings of the three susceptible varieties, Ebène 1/37, B. 3337 and M. 147/44, treated at 52° C for 20 minutes in the experimental tank of the Institute. Five acres have been planted with untreated B. 3337 to serve as control field. Three acres of the treated fields were surveyed four months after planting and only one diseased stool, which was immediately uprooted, detected. Symptoms were abundant at the time in the control plot.

(E). OTHER TRANSMISSION EXPERIMENTS.

Various attempts have been made in several countries in an effort to transmit chlorotic streak from infected to healty plants. The importance of methods that could give a clue as to the way in which the disease spreads in nature is unquestionable; yet, purely artificial methods should not be discarded in such investigations. It does not seem that one of these methods, namely the bridging of two plants by an organic connection afforded by a plant parasite, a method successful with some virus diseases, has been tried in the case of chlorotic streak. A common parasite of cane and maize fields, *Striga hirsuta*, has to be ruled out on account of the difficulties that would be experienced in the experimental procedure. The *Cuscuta* species present in Mauritius do not normally parasitize graminaceous plants, although occasional cases have been encountered on grasses. The partial parasite, *Cassytha filiformis*, present in coastal areas of the island, parasitizes grasses fairly commonly. It is occasionally observed growing on pure strands of *Stenotaphrum dimidiatum*. Connections have been observed, by means of vascular strands, through the haustorium, between bundles of the stem and sheath of the grass and those of the parasite (fig. 20). Experiments are therefore being carried out to establish *Cassytha* on young cane plants in an attempt to transmit the pathogen from diseased to healthy plants.

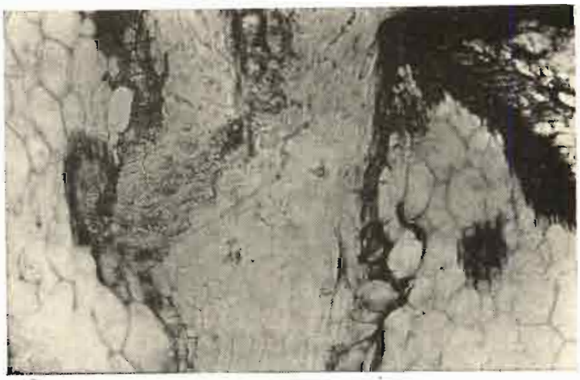


Fig. 20. Vascular strands connecting *Cassytha* through the haustorium to a small bundle (seen on the left) in the sheath of *Stenotaphrum*.

2. RATOON STUNTING DISEASE

Experimental work on ratoon stunting disease was carried out mainly on heat therapy of sugar cane setts. The installation of the experimental hot water treatment tank ordered last year was completed in June. Approximately 125 tons of cane have been treated for the establishment of nurseries and for experimental work.

The survey was continued on estates and the disease, expressed by severe stunting and good symptoms, was observed on B. 3337 and B. 37172. Symptoms were also seen on the white and striped sports of M. 134/32. Growth failures that could be attributed to ratoon stunting are being investigated on M. 112/34 and M. 423/41. The variety Ebène 1/37 is so far showing promise of resistance.

Poor growth attributed to the disease has once more been recorded on M. 134/32 in several localities with high rainfall. It is interesting to note that widespread failure was again observed in that variety on one estate in fields where it was grown with another unidentified variety (probably Co. 301). Widespread infection might have passed from that variety through the cutting knife.

All experiments on M. 134/32 and the other commercial varieties have been replanted after treatment of cuttings in the experimental tank. Results are not yet available. Growth failures in Co. 419 are also being investigated.

HEAT THERAPY

It was necessary to carry out investigations on heat therapy in order to assess the efficacy of the two treatments: hot water at 50° C. for 2 hours and hot air at 54° C. for 8 hours, with varieties grown commercially in Mauritius.

An effective treatment, assuming that the virus is systemic, is a function of several factors:

(i) initial temperature of heating medium, whether water or air, at the time of contact with the mass of cane;

(ii) time taken for stabilization of the medium, after contact; at the given treatment temperature;

(iii) temperature distribution throughout the medium.

The three factors will depend upon the actual design and functioning of the treatment tank or oven. These together with other factors pertaining to the cutting itself, such as botanical nature and size, will all influence the final requirement, i.e. a minimum treatment represented by a definite time-temperature combination given to all cells of the cane sett. In other words, a valid definition in terms of virus inactivation, particularly when the margin for error is small, should take into account the actual treatment inside the cane setts. That has been the basic principle upon which research was carried out in 1956.

(a) *Hot Water Treatment*

Cuttings were heat treated in the laboratory, in a small bath provided with thermostatic control maintaining the temperature at 50° C. A thermocouple attached to a potentiometer was used to determine temperatures inside the cuttings. The water : cane ratio was 6 : 1.

Fig. 21 gives the relation between the square of the radius of the cutting and the time taken to reach treatment temperature inside the cutting. The relation determined for 8 months old setts of M. 134/32 is linear with a correlation coefficient of 0.976. Similar results were obtained with cuttings of Ebène 1/37 of the same age. It is interesting to note that with the thinnest M. 134/32 sett, 2.2 cm. in diameter, the time taken was 13 minutes; whereas, with the thickest, 6.1 cm. in diameter, 75 minutes elapsed before treatment temperature was reached inside the cutting, a difference of 62 minutes. In the case of the thickest Ebène 1/37 cutting treated, 6.3 cm. in diameter,

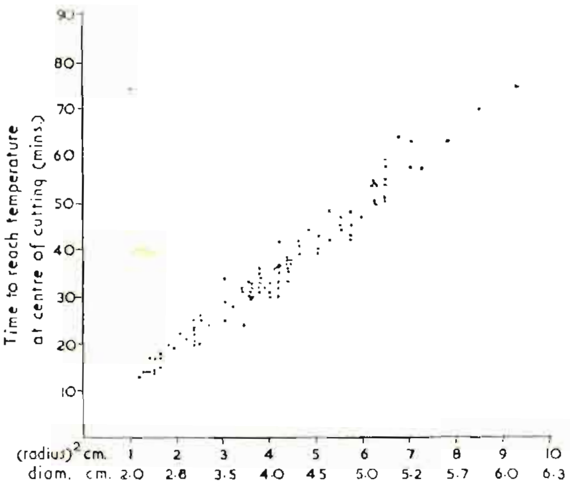


Fig. 21. Relation between diameter of cutting and time to reach treatment temperature of 50° C in hot water at centre of cutting.

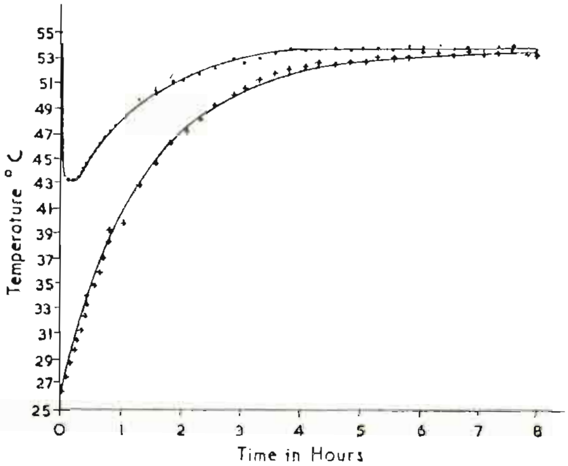


Fig. 22. Temperatures inside air oven (dots) and at the centre of a cutting (crosses) during an 8 hour heat treatment.

50° C. was reached inside the cutting after 85 minutes. It should be pointed out that with varieties such as Ebène 1/37 and M. 134/32, in a random population of cuttings, large ones are common and a few are exceptionally big. If 3.5 cm. is taken as an average diameter for such cuttings, the time taken to reach the temperature inside the cutting is approximately 30 minutes; that means an effective treatment at 50° C. during 90 minutes for the recommended time-temperature conbination. From the point of view of heat therapy, the danger in treating too large cuttings should be stressed.

Temperatures were also determined in the experimental hot water treatment tank described in last year's report, and illustrated in fig. 16. The initial bath temperature was 51° C. After loading the cane mass, stabilization at the treatment temperature, 50.3° C. to 50.4° C., was reached in less than ten minutes. That time is added to the normal treatment time. Thermostatic control has been excellent. Temperature fluctuation determined at several points in the water amidst the cane mass has been consistently of the order of 0.1° C.

(b) *Hot Air Treatment*

Temperatures were determined in a laboratory oven, the internal dimensions of which are 50 cm. x 50 cm. x 60 cm. Air intake was at the top and the outlet was at the bottom and back of the oven. A forced air circulation in close circuit was maintained by means of an electric fan built on rubber piping attached to the oven. The air: cane ratio was 16 : 1 and the cuttings were placed on trays perforated with a large number of holes. Temperatures were taken by means of two thermocouples: one inside the cutting and the other in the immediate vicinity. Fig. 22 gives temperatures in air and inside a cutting, 3.1 cm. in diameter, placed near the centre of the oven.

In the air treatment, when the door of the oven is opened and the cane mass introduced, a sudden drop in temperature ensues. Under conditions of the experiment the highest air temperature, almost equal to the treatment temperature, in the immediate vicinity of the cutting, was reached after 4 hours and temperature inside the cutting reached 50° C. after 3 hours. This means that the whole cutting was maintained at a temperature of 50° C. for approximately 5 hours. Other determinations made in various parts of the oven gave similar curves except that ambiant temperatures varied somewhat.

Temperatures were determined by means of thermocouples in various parts of the oven and it should be noted that, with the low volume of air, small mass of cane and apparently good circulation, the extreme variation in temperature was of the order of 7° C.

(c) *Conclusions*

The hot water treatment is preferred as it appears that it is easier in practice to obtain a good temperature distribution in water than in air. Furthermore, stabilization of the medium at the treatment temperature is reached in water almost immediately after contact with the cane mass. The better temperature control leads to a more uniform treatment of all the setts. One important factor is diameter of setts. A selection of planting material should be made before treatment, and all thick cuttings rejected. In the case of thick-stemmed varieties, such as Ebène 1/37, it is probable that the duration of treatment may have to be extended. This question is under investigation.

The ultimate goal in the campaign against ratoon stunting disease is eradication of the malady; yet, it is not expected to obtain complete control after the first treatments, in spite of all the precautions that could be taken. In the fight against the disease, it is contemplated to construct five large replicas of the experimental tank. These will be located at three treatment centres. The treated canes will serve to establish nurseries which will provide healthy material for commercial plantations. A percentage of cuttings available from the nurseries will be treated again annually for the establishment of new nurseries. If adequate precautions such as sterilization of knives and elimination of volunteer stools are taken in the field, it is hoped that a gradual reduction in the incidence of the disease could be obtained, a result that should be evinced by a progressive increase in yield in the affected regions.

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3. OTHER DISEASES

PINEAPPLE DISEASE

Six fungicides were tested at three concentrations in the control of pineapple disease. Organo-mercurials were significantly better than non-mercurial fungicides. The mercury level, 0.015%, employed in the cold instantaneous dip was confirmed as being the most economic.

Studies in the deterioration of organo-mercurial fungicides in cold and hot baths were continued this year. It was again observed that the fungicide in the hot bath, even with the addition of a stabilizer, deteriorated after 3 days against approximately 16 days in the cold bath. It should be noted that the fungicide is effective at a much lower concentration in the hot bath, in which a longer treatment is given, than in the cold. The mercury content of the bath in the case of the instantaneous cold dip should fluctuate between 0.03% and 0.015% as against 0.004% to 0.002% in the case of the hot bath. It follows that, in spite of the much more rapid deterioration in the hot bath, the amount of fungicide needed to treat one ton of cane is approximately the same in both cases. It is therefore not considered uneconomic to incorporate the fungicide in the hot bath. In the case of the treatment against ratoon stunting disease it would probably be more advantageous to give a fungicidal dip after heat treatment on account of the desirable cooling effect on the hot cuttings.

RED ROT

The effect of age on the susceptibility of cane stalks to red rot was studied. Two varieties were included in the experiment: M. 112/34 and M. 73/31. These differ in their reaction to natural infection in the field as far as penetration of the pathogen is concerned. Twelve planting dates were staggered at monthly intervals from September 1954 to August 1955. There were two rows per plot one for each variety. Twelve primary stalks in each row were inoculated with a spore suspension of *Physalospora tucumanensis* in the middle of an internode at approximately 18″ from ground level, in July 1956. Three months later the spread of the disease was assessed by measuring the length of shoot invaded by the fungus above and below the point of inoculation. One of the plots had to be discarded on account of border effect. Results are given in table 24 and fig. 4 (page 15).

It will be observed that once the pathogen has entered the host, the rate of spread of the fungus inside the shoot is approximately the same. The other interesting observation, confirming previous findings, is that after the period of greatest susceptibility comes one of resistance followed by ultimate breakdown of the cane.

Table 24. Longitudinal spread of Physalospora tucumanensis *in cane stalks of various ages for two varieties.*

Age of cane (months)	% length of stalk invaded by fungus after 3 months	
	M. 112/34	M. 73/31
15	14.0	8.6
16	17.5	11.6
17	17.0	15.4
18	25.2	18.6
19	25.2	20.2
20	20.5	20.4
21	15.4	8.8
22	5.6	8.7
23	*	13.2
24	21.2	22.4
25	41.7	*

* *Stalks damaged by rats*

WEED CONTROL

E. ROCHECOUSTE

1. FURTHER INVESTIGATIONS ON THE USE OF SUBSTITUTED UREAS

FOLLOWING up the work carried out in 1955 a series of experiments were established during the year with a view to obtaining further data on the herbicidal value of the substituted ureas. The trials were also designed to give information on the effects of these compounds on cane yield, both in virgin and in ratoon crops. In order to evaluate their efficacy under different climatic conditions, experiments were laid down in localities differing in soil type and rainfall as shown in table 25 given below.

Table 25. Soil type and rainfall.

Locality	Soil type	Mean annual rainfall in inches
Rose Belle	Rose Belle gravelly clay	150
Valetta	Sans Souci bouldery clay	125
Solitude	Richelieu bouldery clay	38
Magenta	Plaine Lauzun clay	56

Four trials were planted in the following localities: Valetta, Rose Belle, Solitude and Magenta. The Magenta and Solitude trials were established in irrigated lands with due precautions to prevent the carrying away of herbicides from one experimental plot to another.

Experimental

The substituted ureas used in these trials were: CMU 3- (4-chlorophenyl) -1, 1-dimethyl urea and DCMU 3- (3, 4-dichlorophenyl) -1, 1-dimethyl urea.

Of the two compounds DCMU is of more recent introduction in agricultural practice. This compound is claimed by the manufacturers to be more effective than CMU in super-humid localities owing to its greater persistence in the soil, a factor attributed to its low solubility in water: 42 p.p.m. as compared to 230 p.p.m. for CMU.

In this series of experiments CMU and DCMU were applied at the rates 2, 3, 4, 5, 6, 8 and 10 lb. per arpent. Further the treatments 4, 6 and 8 lb. per arpent consisted of two series: one in which these rates were used in one single application and the other in which half of these rates were used in two applications at about two months interval. The object of establishing the two series, was to determine whether the split application would not give a better weed kill, while at the same time diminishing the dangers of damaging the crop. Plot size was 1/50 arpent and the treatments were randomised with fourfold replications. The herbicides were applied in both pre-emergence of the canes and weeds but in the split application treatments of 4, 6 and 8 lb. rates, the second spraying was made in pre-emergence of the weeds and in post-emergence of the canes. Weed assessment was made by the frequency-abundance method two and four months after spraying.

Results and Conclusions: Results obtained from these preliminary investigations are summarized in tables 26 and 27.

As it would be premature to draw conclusions at this stage of experimentation only remarks of a general nature will be made here:

1. no great difference was observed between the two substituted ureas but there are indications that DCMU may prove more effective in the super-humid localities;

2. control of weeds after 4 months was unsatisfactory with both herbicides at all rates used in these trials (table 26);

3. The split application treatments of 4, 6 and 8 lb. rates gave a better weed kill than the single application treatments (table 27).

With regards to the distribution of weed species in the different trials, annuals were by far the more numerous species as shown in table 28 given below:

Table 28. Weed distribution.

Locality	Number of weed species	
	Annuals	Perennials
Rose Belle	18	7
Valetta	29	8
Solitude	21	4
Magenta	32	6

In general the perennial weed species were the least affected by the substituted ureas. Of these may be mentioned:

Phalaris arundinacea	" Mackaye "
Paspalidium geminatum	" Herbe Sifflette "
Cynodon dactylon	" Chiendent "
Cyperus rotundus	" Herbe à oignons "
Paederia foetida	" Lingue "

However few other perennials showed signs of intoxication about a month after spraying and growth was checked for about a fortnight or so after which normal development followed. This was specially noted in the case of *Oxalis debilis* and *O. latifolia* (" oseille ", " trèfle ").

As a rule the germination of most annuals was affected, a few species however, occurred frequently on all the plots irrespective of the rates of applicaton suggesting their resistance to the toxic action of these chemicals. Of these may be mentioned:

Argemone mexicana	" Chardon " (Solitude)
Siegesbeckia orientalis	" Herbe de Flacq " (Solitude)

Table 26. Effects of CMU and DCMU on weed growth. Weed infestation in % of control.

	2 months after spraying												4 months after spraying											
	C M U lb./arpent						D C M U lb./arpent						C M U lb./arpent						D C M U lb./arpent					
	2	4	5	6	8	10	2	4	5	6	8	10	2	4	5	6	8	10	2	4	5	6	8	10
Rose Belle	63	44	42	38	35	32	44	40	32	37	34	25	74	67	71	71	67	67	62	64	65	74	47	49
Valetta	79	57	53	58	47	52	56	50	44	38	36	44	93	103	102	125	85	89	78	92	80	63	56	74
Solitude	68	64	60	49	43	36	72	72	58	66	44	51	71	63	45	55	76	56	72	76	65	76	58	64
Magenta	73	63	66	62	48	56	69	48	55	52	38	35	63	68	63	58	60	53	76	105	96	86	77	85

Table 27. Effects of CMU and DCMU on weed growth. Single application v/s split application. Weed infestation in % control 4 months after spraying.

	CMU lb./arpent						DCMU lb./arpent					
	4		6		8		4		6		8	
	Single	Split	Single	Split	Single	Split	Single	Split	Single	Split	Single	Split
Rose Belle	67	55	71	43	67	49	64	42	74	44	47	40
Valetta	103	65	125	52	85	49	92	47	63	39	56	34
Solitude	63	47	55	45	76	43	76	52	76	35	58	51
Magenta	68	50	58	46	60	63	105	59	86	52	77	44

Amarantus spinosus	" Brède malabar à piquants " (Solitude)	*Echinochloa colonum*	" Herbe de riz " (Magenta)
Setaria pallide-fusca	" Millet sauvage " (Valetta)	*Digitaria timorensis*	" Meinki " Rose Belle

2. EVALUATION OF NEW HERBICIDES

New herbicides received from abroad during the year were tested at Réduit and Belle Rive Experiment Stations situated in the humid and superhumid localities respectively. Their herbicidal value as pre-emergent chemicals was assessed with respect to Agroxone using the small plot technique.

Experimental

The following herbicides were used in the trials:

1. CMU — 3 - (4 - chlorophenyl) - 1, 1 - dimethyl urea
2. DCMU — 3 - (3, 4 - dichlorophenyl)- 1, 1 - dimethyl urea
3. PDU — 3 - phenyl - 1, 1 - dimethyl urea
4. CDAA — 1 - chloro - N, N - diallyl acetamide
5. CDEA — 1 - chloro - N, N - diethyl acetamide
6. Amizol — 3 - amino - 1, 2, 4 - triazole
7. Dalapon — sodium 2, 2 - dichloro-propionate
8. U_{46} Special — butyl glycol ester of 2, 4-D and 2, 4, 5 - T
9. Agroxone 4 — potassium 2 - methyl - 4 - chlorophenoxyacetate.

Plot size was one square yard and the treatments were randomised with fourfold replications. All sprayings were made with an Oxford precision sprayer and the spray solution was kept at the standard rate of 20 gallons per acre and 30 lb. pressure. Weed assessment was made about 10 weeks after the herbicidal spray by the quadrat method in throwing four times a 9 in. quadrat per plot. Both trials were laid down in June and the rainfall distribution in the two localities were as shown in table 29.

Table 29. Monthly rainfall in inches.

Locality	June	July	August	September	Total
Belle Rive	8.97	5.63	6.11	3.72	24.43
Réduit	3.40	1.61	1.92	1.53	8.46

Results and Conclusions

The data obtained in these experiments are presented in table 30 and for convenience the results obtained will be discussed with respect to each class of herbicides:

Table 30. New Herbicides — Weed infestation in % of control 10 weeks after spraying.

Herbicide	Belle Rive Trial										Réduit Trial									
	Rates in lb./arpent										Rates in lb./arpent									
	Annual weeds					Total weeds					Annual weeds					Total weeds				
Substituted ureas	2	3	4	6	9	2	3	4	6	9	2	3	4	6	9	2	3	4	6	9
CMU	53		27			69		40			67		31			61		32		
DCMU	24		9			78		46			65		8			59		10		
PDU	78		58			108		99												
Chloro-acetamides																				
CDAA		88		89	29		121		104	44		112		72	61		97		51	59
CDEA		116		80	52		142		113	57		149		76	54		106		63	59
Others																				
AMIZOL	100		67	21		105		84	48		98		83	109		119		64	88	
DALAPON	62		120	68		101		131	60		115		117	61		77		103	83	
U46 Sp*		18	8				63	19				16	5				28	25		
AGROXONE*		21	15				33	31				32	12				65	46		

* *For U46 Special and Agroxone the rates are expressed in lb. acid equivalent per arpent.*

Substituted Ureas. Of the three substituted ureas, DCMU gave the best results in both localities and CMU was found to be more effective than PDU. At the 2 lb. rate treatment the three chemicals gave rather unsatisfactory control of weeds.

Chloro-acetamides. No difference in phytotoxicity was observed between the two compounds. Although the chemicals did not prove very effective yet there are indications that with an increase in the rates of application satisfactory results can be anticipated.

Dalapon and Amizol. Results obtained are too erratic to draw any conclusions.

U_{46} Special. This chemical gave promising results in both localities and at 4 lb. acid equivalent per arpent it was consistently better than Agroxone. In the Belle Rive trial weed assessment in the 3 lb. acid treatment was as high as 63 for U_{46} special compared to 33 for Agroxone. This difference may be attributed to the presence of a high proportion of *Digitaria timorensis* "meinki" in the U_{46} experimental plots, a species almost absent in the Agroxone plots.

3. OTHER INVESTIGATIONS

(a). *"Herbe Sifflette"* (Paspalidium geminatum)

This grass is a troublesome weed of marshy lands reclaimed for sugarcane growing (cf. Ann. Report 1954). It has an extensive system of rhizomes and stolons and once established in a field it soon becomes the dominant species. Experiments started in 1954 with sodium chlorate and TCA having given unsatisfactory results further investigations were carried out during the years 1955 and 1956, with a view to evolving better methods of control for its eradication.

Experiment I, 1955. This experiment was designed to combine chemical weeding and mechanical cultivation. Two plots of 1/5 arpent each were selected in a pure sward of the grass. One was cross-ploughed with a rotary hoe and the other was left undisturbed The plots were then sprayed with a mixture TCA and Sodium chlorate at the following rates per arpent : TCA = 100 lb., Sodium chlorate = 40 lb.

Results. Observations made at monthly intervals during the first three months following the treatment are summarized in table 31.

Table 31. Effects of TCA and Sodium Chlorate on Herbe Sifflette.

Treatment	Regrowth incidence :		
	after one month	after two months	after three months
Undisturbed grass	no regrowth	about 25%	about 75%
Ploughed grass	about 5%	”	about 60%

Three months after the application of the herbicide, the plots were hand weeded for all other weed species with the exception of "herbe sifflette". The ploughed plot was then reploughed and both plots received the same herbicidal treatment again. The data obtained are shown in table 32.

As will be seen from tables 31 and 32 mechanical cultivation has not increased the effectiveness of the herbicide treatment. It must be stated however, that heavy rains fell on the plots three months after the second ploughing, that is, just after the second observation had been made. Thus some of the chemicals from

Table 32. Effect of second application of TCA and Sodium Chlorate on "Herbe sifflette".

Treatment	Regrowth incidence :		
	after two months	after three months	after four months
Undisturbed grass	25%	40 — 50 %	complete regrowth
Ploughed grass	15%	30 — 40 %	about 80 %

the plots was probably washed away, a factor which may explain the high regrowth incidence recorded at the last observation (Table 32).

Experiment II, 1956. The new herbicide Dalapon (sodium 2, 2 - dichloropropionate) and Amizol (3 - amino 1, 2, 4 - triazole) having been received in small quantities at the Institute, experiments were laid down in 1956 so as to study their effects on *Paspalidium.* Dalapon closely resembles TCA in its effects on grasses but differs from it in that it can be absorbed by the leaves. Amizol on the other hand is an active compound which on being absorbed by the plant interferes with the chlorophyll synthesis producing characteristic chlorotic or albino shoots.

Trial I. Plots of about 400 sq. ft selected in a pure sward of the grass in marshy land at Magenta received the following treatments (lb. per arpent).

1. TCA 100 + Dalapon 40
2. TCA 100 + Amizol 40
3. Dalapon 100
4. Amizol 200
5. ,, ·100
6. ,, 50

Results. Observations made at monthly intervals are presented in table 33, from which it may be seen that Dalapon at 100 lb./arpent and Dalapon 40 lb. + TCA 100 lb. per arpent were the most effective treatments. In the first two months following the treatment Amizol produced striking effects of albinism in the plant. However, these disappeared gradually and the grass resumed normal growth thereafter. On the other hand the toxic action of Dalapon, though slow to show up, persisted in the plant, resulting finally in a better kill.

Trial II. The layout of this trial was based on results obtained in trial I TCA and Dalapon were used in various combinations at the following rates in lb./arpent:

1. TCA 100 + Dalapon 40
2. ,, 100 + ,, 20
3. ,, 60 + ,, 40
4. ,, 60 + ,, 20
5. ,, 40 + ,, 40
6. ,, 40 + ,, 20
7. ,, 20 + ,, 40
8. ,, 20 + ,, 20

Results. Observations made in December 1956, that is, three months after spraying showed that:

(i) TCA 100 + Dalapon 40; TCA 100 + Dalapon 20; TCA 60 + Dalapon 40 were the most effective treatments giving about 60% control of the grass.

(ii) of the other treatments it can be said that only a temporary effect was observed.

General Conclusions. Trial I was laid down in the first week of June and trial II in mid-September. The distribution of rainfall in the locality during the period the experiments were being conducted was as follows:

Table 33. Effects of Dalapon and Amizol on Paspalidium geminatum.

Treatments (rates/arpent/200/gall. water)	Effects on grass.			
	After one month.	After three months.	After four months.	After six months.
Dalapon 100 lb.	Growth checked, slight chlorosis.	Most of the top-growth has died out, no regrowth.	Complete top kill, no regrowth.	Regrowth incidence insignificant-less than 5%.
Dalapon 40 lb. TCA 100 lb.	Same results as treatment: Dalapon 100 lb.			
Amizol 200 lb.	Growth severely checked. A high proportion of shoots showing albinism.	About 15% regrowth, most of the albino shoots returning to normal colour.	Albinism has disappeared completely, about 5% regrowth.	About 50% regrowth.
Amizol 100 lb.	As above but less pronounced.	About 25% regrowth, albino shoots almost absent.	About 40 — 50% regrowth.	About 80% regrowth
Amizol 50 lb.	Growth checked. albinism of shoots occasional.	About 40% regrowth. All shoots of normal colour.	About 50 — 60% regrowth.	Complete recovery.
Amizol 40 lb. TCA 100 lb.	Same results as treatment Amizol, 50 lb.			
Amizol 20 lb. TCA 100 lb.	Growth checked with a slight scorching effect.	Plants have recovered their full vigour.	Complete recovery.	

Months	Rainfall in inches
June	0.40
July	0.40
August	0.47
September	0.36
October	0.36
November	1.83
December	6.79

Comparing the results obtained in trials I and II it seems obvious that the efficacy of the treatments in trial II has been affected by rainfall. In fact only 1.99 inches of rain was registered during the first five months following the laying down of trial I whereas in trial II, the first summer rains started about 8 weeks after spraying. Another point of interest is that the combination TCA-Dalapon seems to depend on a certain minimum level of TCA to be able to exercise a full phytotoxic effect. Results of trial II suggest that this level is about 60 lb. per arpent; when this rate is lowered while that of Dalapon is kept at the same level only temporary injury was caused to the grass.

(b) *Herbe Bleue* (Verbena sp.)

This ornamental plant which has escaped cultivation is now found growing as an occasional weed of road sides and waste places. It has never been reported as being a troublesome weed of cane fields until 1956, when its presence in the Pamplemousses area has been the cause of much concern to sugarcane growers. The plant is a sturdy perennial with vigorous trailing shoots bearing heads of beautiful lilac flowers. Owing to a robust and much branched root system it establishes itself firmly in the soil reaching at times a depth of 2 to 3 ft. Although it may produce fertile seeds yet its spread in the field mainly occurs through mechanical cultivation; fragments of roots transported by the plough establish new foci of infestation whenever they are deposited in the field.

Investigations started this year on the chemical eradication of this weed are summarized below:

Experiment I. Exploratory work carried out in infested fields having shown that the amines and esters of 2, 4 - D gave only a temporary control, further experimental work was carried out as follows.

Interlines of canes infested with the weed were sprayed with the following chemicals at rates given below in 100 gallons of water per arpent.

1. Arsenite solution 1 gallon
2. " " 2 gallons
3. Arsenite solution 4 gallons
4. " " 2 " + TCA 20 lb
5. Dalapon 20 lb
6. " 10 lb
7. Amizol 20 lb
8. " 10 lb

Arsenite solution used in the experiment was a liquid concentrate containing 50% As_2O_3.

Results. 1. Arsenite was the best treatment and there was little to choose between the 2 and 4 gallons treatments. It must be emphasized, however, that 10 weeks after the treatment about 80% of the plants had resumed normal growth.

2. The addition of TCA to the arsenite solution did not increase the herbicidal value of the treatment.

3. Dalapon at both rates was ineffective.

4. Amizol produced partial albinism of the leaves, but such effects did not persist and normal development soon followed.

Experiment II. In this experiment the following herbicides were used at the rates mentioned below in 100 gallons of water per arpent:

1. CMU — substituted urea — 8 lb.

2. "Geigy" weed killer — 50% chloroamino-triazine — 8 lb

3. CDAA — chloro-acetamide — 5 lb.

4. CDEA — ,, — 5 lb.

Results. CMU caused a severe set back to the weed during the first month following the trial. Leaves turned yellowish and shoots became drawn out, but subsequently normal growth was resumed.

"Geigy". Similar effects to CMU but more pronounced.

CDAA, CDEA } only temporary injury was produced.

Investigations on the chemical eradication of this weed have so far given unsatisfactory results. Consequently it is not possible at present to make any recommendations with regard to its control by chemical method.

Fig. 23. Evaluation of new herbicides by the small plot technique using an Oxford precision sprayer.

Fig. 24. Overhead irrigation of young cane plantations at Constance S. E.

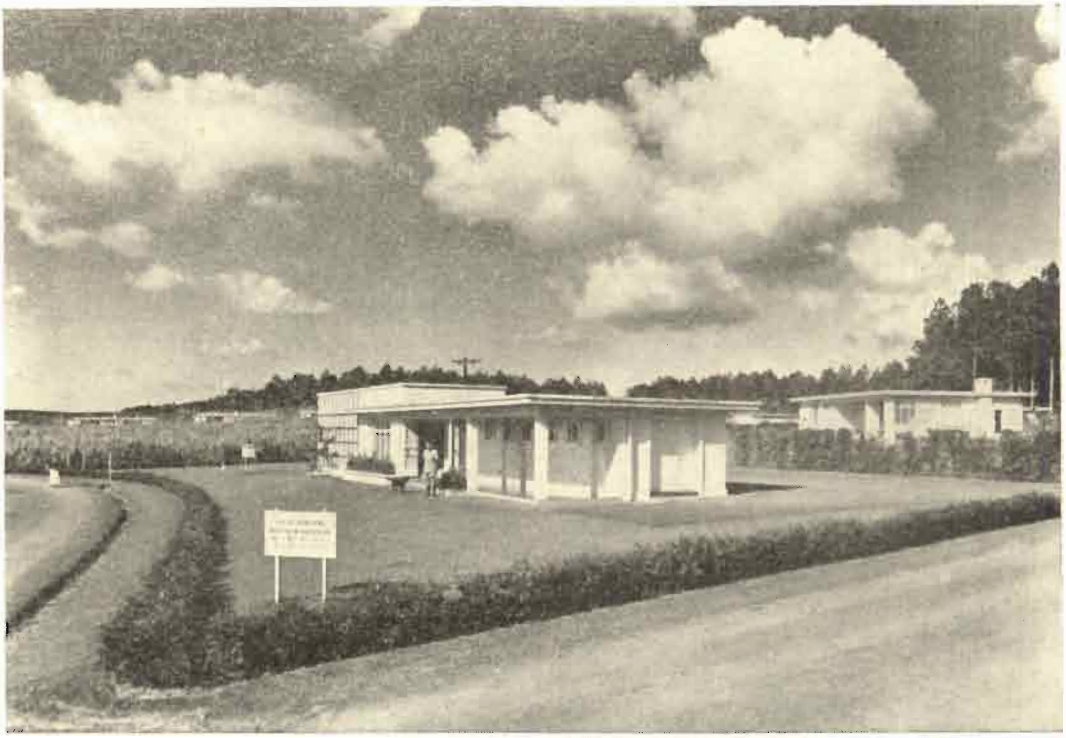

Fig. 25. Offices, Belle Rive Experiment Station.

FURTHER INVESTIGATIONS ON THE EFFECT OF RAINFALL ON SUGAR PRODUCTION

PIERRE HALAIS

THE recent introduction in the 1954 Annual Report of this Institute of the sum of November—June monthly rainfall deficits (D) and the sum of July—October monthly rainfall excesses (E) derived from actual data and monthly normals for characterizing annual climatic changes, has thrown much light over the decisive influence of rainfall on the annual fluctuation of sugar production in Mauritius.

Furthermore, rainfall deficits and excesses encountered during the 1955 and 1956 sugar campaigns have deeply influenced sugar production in the way forecasted by this new concept. It follows that the results now available for the decade 1947—1956, free from the disturbing influence of any severe cyclone, constitute almost ideal data for broadening the conclusions drawn earlier.

CANE TONNAGE

During the decade under review November—June deficits have varied for the whole Mauritius sugarcane zone, between the extremes of 22.6 inches in 1947, and 7.1 inches in 1953 as against a long time normal of 15 inches, whilst final tons of cane per arpent have fluctuated between 21.4 in 1947 and 27.8 in 1953 (table 38, page 80).

Table 37 gives the regression coefficients (b), i.e. the decrease in cane tonnage following a deficit of one inch rainfall for the Island as a whole, the west-north, the east-south and the centre sugar sectors. The new coefficients obtained are practically the same as those found earlier for the eight year period 1947-1954. The various correlation coefficients (r) calculated between November—June deficits and cane tonnage per arpent are well above the 1% level of significance.

Evidently, caution should be exercised when interpreting the November—June deficits, for, as it happened in February 1955, the rains started a few days before the end of the month following two consecutive drought months. It is precisely during this 1955 campaign that the highest difference of 1.3 tons cane per arpent was observed between calculated (26.4) and actual (25.1) tonnages.

CANE QUALITY

During the 1947-56 decade, July—October excesses have varied for the whole Mauritius sugar cane zone, between 0.00 inches in 1947, 1949 and 1956 and 6.25 inches in 1953, as against a long time normal of 2.5 inches, whilst final sugar manufactured % cane fluctuated between 12.41, 12.40 and 12.94 in 1947, 1949 and 1956 and 11.03 in 1953 respectively.

At first it was thought desirable (see Annual Report M.S.I.R.I. 1954) to fit a multiple regression involving both excess and deficit in order to account for the strain put on labour and sugar mills when dealing with high cane tonnage crops following low deficits (D). Subsequently, the 1955 and 1956 results for final sugar manufactured % cane have shown that this correction was no more required as the capacity and efficiency of sugar mills have steadily improved and could cope with larger crops without material losses. Consequently, new single regressions involving only

July—October excesses were calculated for the whole decade. The validity of this procedure is being proved by the high correlation coefficients obtained and shown in table 37, which also gives the regression coefficient (b) i. e. the decrease in sugar manufactured % cane following an increase of one inch in the July—October excesses.

SUGAR PRODUCTION PER ARPENT

Table 38 shows the actual and calculated sugar production for each year between 1947 and 1956. The correlation coefficient between actual and calculated sugar production per arpent is high, reaching + 0 90. This means that, provided the total area reaped is known, approximately 80 % of the annual fluctuation in the sugar production of the Island can be ascribed to variations in November—June rainfall defecits and July—October rainfall excesses, when no strong cyclone intervenes.

EFFECT OF AIR TEMPERATURE

Accurate temperature data collected at the three Government Stations from 1949 onwards have been made available by the Meteorological Department. This eight-year period is highly suitable for studying the contributory influences of rainfall and temperature on final sugar manufactured % cane, as four years of bad maturity, 1951 to 1954, have been framed by four years of good maturity, 1949–50 and 1955–56. Table 35 gives the average figures for the two contrasted groups of 4 years and for the maturation period July to October.

Table 35. Rainfall, temperature and cane maturity 1949 — 1956.

Years	Maturity	Total Rainfall	July–Oct. Excesses E	Max. Temp.	Min. Temp.
1949–'50 & '55–'56	good	11.4 in.	0.43 in.	24.2°C	16.3°C
1951–54	bad	19.0 in.	4.87 in.	24.1°C	16.9°C

The various correlation coefficients calculated between sugar manufactured % cane and the four other variables are:

Total Rainfall	July—Oct. Excesses E.	Max. Temp.	Min. Temp.
—0.839	—0.925	+0.412	—0.698

The only two significant (1% level) correlation coefficients are between sugar manufactured % cane / total rainfall and sugar manufacture % cane / July — October excesses. Evidently, the correlation of —0.698 with minimum temperature is positively associated with low rainfall excesses under Mauritius climate. In addition, such a small difference as 0.6°C between the minimum temperature averages of the good and bad maturity groups actually reflects wider and more significant variation in average rainfall excesses (0.41 and 4.87 inches) for the good and bad maturity grouping, respectively.

THE 1956 CAMPAIGN

The happy conjunction of a small November–June rainfall deficit of 8.6 inches coupled with July—October rainfall excess of zero along with highest wind speed recorded during one hour not exceeding 20 miles, has never occured in the past, that is, since regular meteorological information started in 1875.

It is not surprising, therefore, that the 1956 sugar campaign should have reached such exceptional height, viz: 14% sugar production above that of a normal year without cyclone. The North sector heading with 23%; West 18%; East and South 11% and Centre, 10%.

LATEST NORMALS

The actual production data for the last two years, 1954 and 1956, have to be adjusted to a normal meteorological year of November — July deficit of 15.0 inches and July—October excess of 2.5 inches, in order to determine the latest available normals given in table 36. These normals strictly correspond to the intermediate year 1955. The high stability of the millers' normals for tons of sugar per arpent obtaining in the five sectors is remarkable and is due to numerous compensating factors.

Table 36. Normal cane and sugar production of different sectors of Mauritius.

	Tons cane per arpent		Sugar manufactured % cane	Tons sugar per arpent	
	Average	Millers		Average	Millers
Island	24.0	30.1	12.15	2.92	3.69
West	25.1	29.8	12.30	3.09	3.67
North	21.7	29.1	12.58	2.73	3.65
East	21.6	29.9	12.03	2.60	3.61
South	26.6	30.6	11.72	3.12	3.60
Centre	25.7	31.3	12.39	3.18	3.85

Table 37. Regression and correlation coefficients between rainfall deficits and excesses and yield of cane and sugar.

	November—June Deficits Tons cane per arpent		July—October Excess Sugar manufactured % cane	
	Regression Coefficient (b)	Correlation Coefficient (r)	Regression Coefficient (b)	Correlation Coefficient (r)
Mauritius	0.311	—0.924	0.252	—0.928
West & North	0.560	—0.916	0.310	—0.919
East & South	0.196	—0.869	0.246	—0.888
Centre	0.198	—0.858	0.150	—0.696

Table 38. Rainfall data and sugar production of Mauritius.

Year	November June deficit, inches	Tons cane per arpent, actual	Tons cane per arpent, calculated	June-Oct. excesses, inches	Sugar manufactured % cane, actual	Sugar manufactured % cane, calculated	Tons sugar arpent actual	Tons sugar arpent calculated
			(b = 031)			(b = 025)		
1947	22.6	21.4	22.0	0.00	12.41	12.58	2.65	2.77
1948	21.8	23.2	22.3	0.61	12.40	12.42	2.88	2.77
1949	17.2	23.3	23.7	0.00	12.40	12.58	2.89	2.98
1950	14.7	24.6	24.5	0.87	12.28	12.36	3.02	3.03
1951	7.4	27.3	26.7	3.87	11.12	11.60	3.04	3.11
1952	12.3	24.8	25.3	5.61	11.42	11.17	2.83	2.81
1953	7.1	27.8	26.8	6.25	11.03	11.00	3.06	2.95
1954	12.9	25.4	25.0	3.76	11.65	11.63	2.96	2.91
1955	8.4	25.1	26.4	0.85	12.61	12.38	3.19	3.27
1956	8.6	26.0	26.3	0.00	12.94	12.58	3.37	3.31
Averages	13.30	24.9	24.9	2.18	12.03	12.03	2.99	2.99

CULTIVATION AND IRRIGATION

1. TRASH DISPOSAL

GUY ROUILLARD

THE most efficient method of trash disposal is a problem of some economic importance in cane cultivation in Mauritius, as on the average 6 man-days per acre per annum are required to line the trash along inter-rows of cane after harvest. Local practice varies chiefly depending upon climatic zones. Thus, under conditions of high rainfall, trash is readily decomposed, and the volume available is barely sufficient to cover one interline in two. In the humid and sub-humid zones, trash is usually disposed of in the form of a uniform blanket along alternate interlines, although some planters prefer lining the trash along every interline.

This practice had been studied by the Sugarcane Research Station in the past, and the results obtained were commented as follows by Evans (S.R.S. report for 1940, p. 19):

"In all the trials reaped, no beneficial effect of burying trash has been demonstrated either in individual trials or when the results of several trials are combined. Treatments in which trash was heaped on the surface yielded as well as treatments in which trash was buried, irrespective of the method of burying. It would appear however that under Mauritius conditions no benefit from burying trash is apparent in trials repeated for 3 years".

From 1949 to 1953 two series of experiments were carried out by the author in order to determine, if different methods of trash disposal had an influence on cane yield.

The first series consisted of 5 experiments in the humid and sub-humid zones of the island. Each trial consisted of 24 plots of 6 cane rows 50 ft. long. Lining trash along every interline after harvest was compared to lining along alternate interlines. The two centre rows of each plot were weighed at harvest.

Cane weights were obtained during 3 consecutive years, in three of the trials, and in 4 consecutive years in two of the trials.

The results obtained were as follows:

	Tons cane/arpent
Trash on every interline ...	34.25
„ „ alternate interline ...	33.91
Difference in yield ..	0.34
Sig. diff. ..	± 0.64

In the second series of experiments, leaving the trash undisturbed after harvest was compared to lining trash along every interline Four trials were conducted on estates in the north of the island (sub-humid to humid zone), with similar plot sizes to those of the first series described above. Cane weights were recorded during a period of 4 years with the following results:

	Tons cane/arpent
Trash undisturbed after harvest ...	29.25
„ lined along every interrow ...	29.03
Yield difference ...	0.22
Sig. „ ..	±0 87

It appears from both series of experiments that cane yields were not affected by one of the several methods used for trash disposal. Depending upon availability of labour however, it should be pointed out that the practice of lining trash as carried out in Mauritius has several practical advantages such as better supervision of fertilizer application on ratoons and more efficient control of weeds.

2. OVERHEAD IRRIGATION

G. MAZERY

REVIEW OF PAST EXPERIMENTS

During the past five years overhead irrigation of sugarcane fields had been attempted on a limited scale by a few planters. However, due to inadequate planning, unsuitable equipment and several other factors, this method of irrigation proved uneconomical and was abandoned. In 1953-54 an experiment was carried out at Médine S. E. under the auspices of the Irrigation Committee of the National Resources Board. There again no definite conclusions could be arrived at because the equipment was inadequate so that part of the experimental plots could not be irrigated at all and no efficient control could be exerted on the running of the experiment.

In July 1954, the Institute was called upon to advise in connection with a new experiment on a large scale, from which information of commercial value could be obtained. An agreement has now been arrived at whereby the Government and the Sugar Industry Reserve Fund will provide the necessary funds while the Institute will be entrusted with the care of implementing the experiment. A preliminary survey of the selected site at Médine S. E. has been carried out.

RECENT DEVELOPMENTS

In September 1956, Constance S. E. received a portable equipment for overhead irrigation, intended primarily for young cane plantations in the rocky areas of the estate. Due to the wide dispersal of the young plantations throughout the area, the whole irrigating system had to be moved frequently; as a result, maximum efficiency could not be obtained and the cost of application of water per acre inch was high. Greater efficiency will be possible when a detailed map of the area is completed and the planting programme planned in accordance with the requirements of overhead irrigation.

The Manager of Constance S. E. kindly afforded many facilities for various studies connected with overhead irrigation. Some of the results of these experiments are summarized below.

EXPERIMENTAL

(i). Water Distribution

In order to determine water distribution around each sprinkler and their optimum spacing, the following experiment was carried out: six "rainbird rainers" were placed on risers 8 feet above ground level and 250 feet apart, this distance being sufficient to prevent overlapping of the areas watered by each rainer. The six rainers were worked simultaneously and the water pressure at the foot of each rainer kept at 65 to 70 lbs per square inch. The water falling on the ground was collected by means of containers placed at 10 ft. intervals on the two diameters of a circle cutting each other at right angles and having the rainer at the centre of the circle. During the tests, the weather conditions were normal i. e., the sun was shining and the average wind velocity was below 10 m.p.h.

The water collected round each rainer showed slight variation. The average rainfall per hour at various distances from the rainers is given in fig. 26.

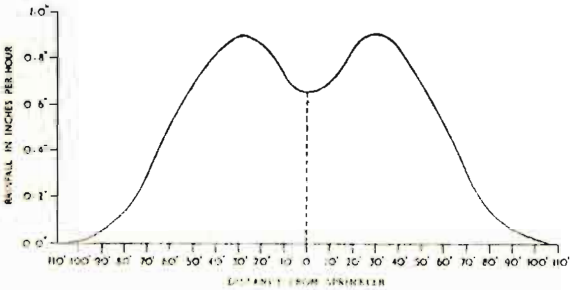

Fig. 26. Distribution of water at varying distances from rainer.

Fig. 27 illustrates the uniformity of water distribution which may be obtained with overhead irrigation when the rainers are placed in the conventional pattern.

It was unfortunately not possible to measure the actual volume of water at the pump in order to assess the losses due to wind drift and evaporation. The data obtained however show that with the equipment available it is possible to apply 0.9″ of water uniformly over 1.70 acres in one hour or approximately 1.5 acre inch of water per hour under normal working conditions.

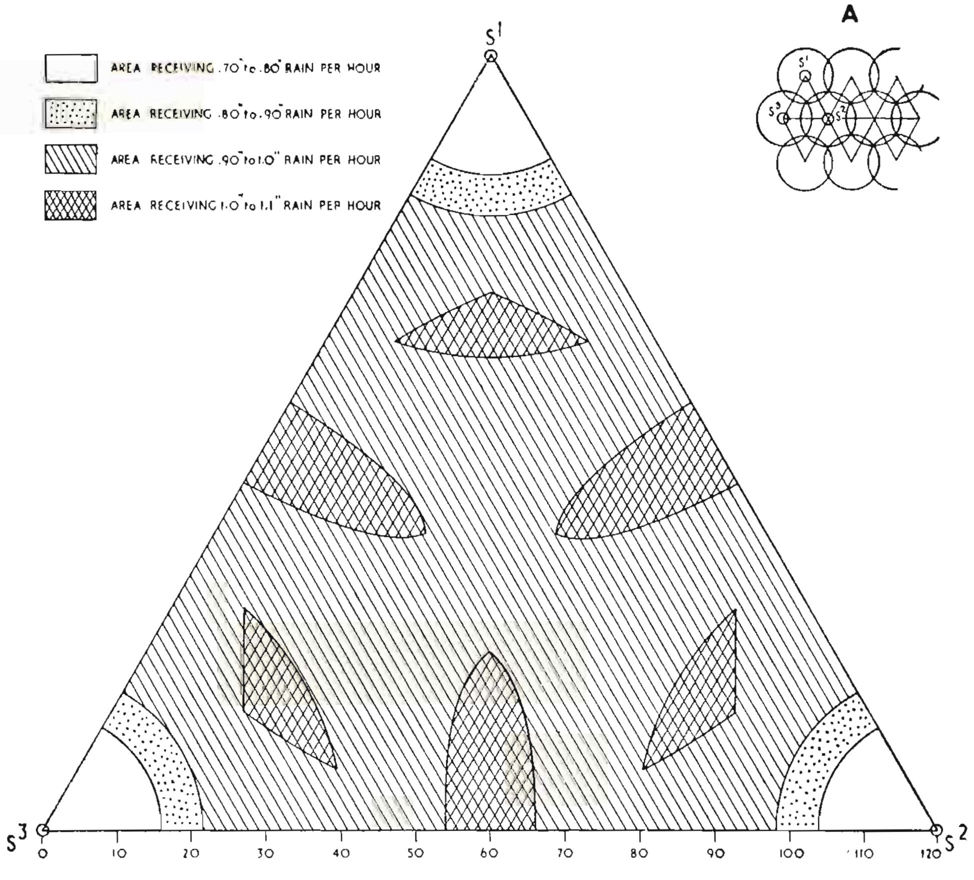

Fig. 27. Distribution of water from sprinklers S1, S2, S3 when arranged in the conventional patern shown at A.

(ii). *Water retention capacity and available moisture*

Preliminary tests were made for estimating total water retention capacity of soils and available moisture, these data being essential for determining the amount of water to be applied by overhead irrigation and time intervals between applications. Three types of soils were tested:

(i) Richelieu bouldery clay, (ii) Plaisance gravelly clay loam under cane cultivation for over 30 years and (iii) Plaisance gravelly clay recently put under cultivation. The total moisture was calculated on the weight of oven-dried soil and the available moisture determined by means of "Bouyoucos" moisture cells.

The results obtained are given in table 34.

These data indicate that there is an appreciable variation in the characteristics of the types of soil tested with regard to soil moisture, but further studies concerning the depth of soil explored by the sugarcane roots and percentage of rocks in the soil must be made before definite conclusions can be arrived at.

Wilting point determinations were made using tomato as test plant with a view to obtaining approximate data with respect to three types of soil studied in the moisture tests mentioned above. No appreciable difference could be observed between the various types of soil, the plants showing signs of wilting when the available moisture readings dropped to below 10.

Table 34. Water retention of three soil types.

	% water in saturated soil. (Available moisture = 100)	% water when available moisture = 0	Available moisture drops steeply at a total moisture content of :
(i) Richelieu Bouldery Clay	62	less than 26	32%
(ii) Plaisance Gravelly clay loam (cultivated for over 30 years)	53	,, ,, 20	26%
(iii) Plaisance Gravelly clay loam (recently cultivated)	57	,, , 18	26%

A series of measurements has been made with the object of studying cane growth in relation to available soil moisture. However, the difficulty in eliminating other factors did not allow conclusions to be drawn from these observations. Further work on growth measurements is in progress.

SUGAR MANUFACTURE

1. COIL VERSUS CALANDRIA VACUUM PANS FOR THE BOILING OF C-MASSECUITES.

J. DUPONT DE R. ST. ANTOINE

WHETHER coil or calandria vacuum pans should be used for the boiling of C-massecuites is still a controversial subject. If in certain countries, such as Hawaii, only calandria pans are used, in others such as Australia, coil pans are greatly predominant (1).

Similarly, sugar technologists and engineers have different views on the subject. According to Perk (2) and to Venton (3, 4), for example, coil pans are to be preferred to calandria pans for the boiling of C-strikes. Hugot (5) on the other hand is a great advocate of calandria pans.

It is not the object of this paper to try and solve the controversy, the more so that it would be impossible to arrive at a definite conclusion unless a great number of comparisons were made to take care of the numerous differences existing in the designs of various coil and calandria vacuum pans. The purpose of this experiment is to determine whether, with the equipment available in Mauritius factories, it would not be advantageous to boil C-massecuites in calandria rather than in coil pans (as is already being done in some cases) and, with the help of the results obtained, to guide factory engineers who may be faced with the problem of ordering vacuum pans for the boiling of C-strikes.

Prior to the 1956 crop it was therefore decided to carry out a series of comparisons on a few representative sugar factories, but due to several difficulties it was not possible to obtain sufficient results from more than three factories, located one in the North, one in the South and the third in the Centre of the island. The results obtained in each of these factories are given in tables 40 to 45, and are summarized in table 39.

Table 39.

Factory	Type of Vacuum Pan Used	Number of Tests	Boiling Time (hours)	Massecuite		Cooling Time (hours)	Final Molasses	
				Brix	App. Pty.		Brix	Gravity Purity
Labourdonnais	Calandria	13	4.20	100.3	56.6	47	98.1	36.4
Mon Trésor	Calandria	8	4.75	99.3	51.0	113	91.7	35.9
Réunion	Calandria	5	4.20	98.6	52.4	89	91.1	40.3
Average	Calandria	—	4.37	99.7	54.1	83	94.7	37.0
Labourdonnais	Coil	14	8.90	100.1	56.3	56	98.6	36 5
Mon Trésor	Coil	8	10.64	100.3	50.4	124	91.1	36.5
Réunion	Coil	5	8.00	98.7	51.9	92	90.5	40.0
Average	Coil	—	9.25	99.9	53.7	91	94.9	37.1

Factory : LABOURDONNAIS

Table 40. Calandria Vacuum Pan by A. & W. Smith.

Diameter ... ... 10 ft.
Working height above upper tube sheet ... 7 ft.
Working capacity ... ... 30 tons
Graining Volume (%working capacity) ... 25%

Tube length ... ... 39 in.
Tube ext. diam. ... ... 4 in.
Heating surface ... ... 1180 sq. ft.
Centre well diam. ... 4 ft. 6 in. – 3 ft. 9 in.

Date	Boiling Time (hours)	Massecuite Temperature			Cooling Time (hours)	Massecuite		Final Molasses	
		on dropping °C.	after cooling °C.	after reheating °C.		Brix	App. Pty.	Brix	Gravity Purity
17.9.56	4.0		28	—	49	100.1	59.0	99.2	35.8
18.9.56	4.5		28	—	62	100.4	56.7	97.4	36.3
20.9.56	4.0		31	—	28	99.3	59.0	98.7	36.6
21.9.56	3.5		32	—	26	99.5	57.7	94.3	37.5
21.9.56	4.5	65	27	—	58	99.8	56.5	98.5	34.6
22.9.56	4.5		28	—	56	99.4	57.5	98.5	35.8
24.9.56	4.0	to	30	—	36	100.7	54.9	98.7	37.3
27.9.56	4.7		30	—	30	100.8	54.9	97.4	37.1
27.9.56	3.5	70	28	—	96	101.6	55.3	99.0	36.1
28.9.56	4.8		28	—	77	99.5	56.6	97.9	37.7
1.10.56	4.0		30	—	37	101.2	56.5	97.9	36.6
2.10.56	4.0		32	—	28	101.1	55.4	99.0	36.9
3.10.56	4.0		30	—	27	100.1	55.8	100.2	35.3
Average	4.2	—	30	—	47	100.3	56.6	98.1	36.4

Table 41. Coil Vacuum Pan by A. & W. Smith.

Diameter ... ... 9 ft. 6 in.
Working height ... ... 6 ft. 6 in.
Working capacity ... ... 25 tons
Graining volume (%working capacity) 25%

Number of coils 5
Length of coils ... .. 100 ft.
Diam. of coils ... .. 4 in.
Heating surface ... ... 620 sq. ft.

Date	Boiling Time (hours)	Massecuite Temperature			Cooling Time (hours)	Massecuite		Final Molasses	
		on dropping °C.	after cooling °C.	after reheating °C.		Brix	App. Pty.	Brix	Gravity Purity
17.9.56	7.8		28	—	66	99.1	58.5	98.7	37.4
18.9.56	10.0		30	—	60	100.9	56.5	97.7	37.0
20.9.56	7.5		30	—	36	98.9	60.2	98.5	38.0
22.9.56	13.0		30	—	41	100.5	55.6	99.5	35.5
22.9.56	10.0	65	28	—	62	100.1	57.0	97.9	36.4
24.9.56	8.2		28	—	56	100.4	54.4	99.0	36.7
25.9.56	6.0	to	33	—	37	101.2	55.1	99.0	36.2
26.9.56	10.8		30	—	36	99.9	54.2	98.5	36.1
27.9.56	10.0	70	28	—	88	101.6	55.3	99.0	36.1
27.9.56	7.5		28	—	101	101.1	54.8	99.5	36.0
28.9.56	7.7		28	—	91	99.8	56.5	98.7	35.3
1.10.56	11.5		31	—	35	98.9	57.8	98.7	36.7
3.10.56	8.0		30	—	34	101.2	56.6	98.2	36.7
3.10.56	7.0		30	—	38	98.4	56.2	97.9	36.2
Average	8.9	—	30	—	56	100.1	56.3	98.6	36.5

Factory : MON TRESOR

Table 42. Calandria Vacuum Pan by Fletcher

Diameter	13 ft.	Tube length	42 in.
Working height above upper tube sheet	9 ft. 6 in.	Tube ext. diam.	4 in.
Working capacity	36 tons	Heating surface	1450 sq. ft.
Graining volume (%working capacity) ...	35%	Centre well diam.	5 ft.

Date	Boiling Time (Hours)	Massecuite Temperature			Cooling Time (hours)	Massecuite		Final Molasses	
		on dropping °C.	after cooling °C.	after reheating °C.		Brix	App. Pty.	Brix	Gravity Purity
4.9.56	5.8	71	29	42	—	100.0	48.9	90.4	37.8
7.9.56	4.5	69	30	40	58	100.0	49.4	91.9	36.1
20.9.56	4.2	70	—	—	155	99.0	49.3	93.0	36.1
27.9.56	4.8	70	31	40	149	99.2	47.1	93.3	34.3
29.9.56	4.7	70	28	42	53	98.5	55.9	89.6	36.5
4.10.56	4.5	69	29	40	152	99.5	52.2	93.2	36.0
5.10.56	5.0	69	30	40	148	98.7	54.8	91.3	35.4
8.10.56	4.5	70	29	38	74	99.5	50.6	90.8	35.1
Average	4.75	70	29	40	113	99.3	51.0	91.7	35.9

Table 43. Coil Vacuum Pan by Harvey

Diameter	12 ft.	Number of coils	12
Working height	12 ft.	Length of coils	80 ft.
Working capacity	32 tons	Diam. of coils	4 in.
Graining volume (%working capacity) ...	30%	Heating surface	1,000 sq. ft

Date	Boiling Time (hours)	Massecuite Temperature			Cooling Time (hours)	Massecuite		Final Molasses	
		on dropping °C.	after cooling °C.	after reheating °C.		Brix	App. Pty.	Brix	Gravity Purity
4.9.56	12.5	70	30	41	—	100.8	48.5	91.6	36.0
7.9.56	10.0	69	31	40	76	99.8	49.5	88.6	37.4
20.9.56	9.3	69	—	—	150	100.3	49.8	91.8	34.8
27.9.56	10.5	70	30	41	153	101.5	48.7	92.6	34.5
29.9.56	6.8	68	27	40	61	99.2	50.3	90.7	37.0
4.10.56	12.5	69	26	40	186	101.8	49.5	90.8	36.3
5.10.56	13.0	69	26	40	167	100.3	53.9	90.8	37.1
8.10.56	10.5	71	28	41	76	98.5	52.8	91.7	38.9
Average	10.64	69	28	40	124	100.3	50.4	91.1	36.5

Factory : REUNION

Table 44. Calandria Vacuum Pan by G. Maurel

Diameter	... 11 ft.	Tube length	.. 36 in.
Working height above upper tube sheet	... 7 ft.	Tube ext. diam.	... 4 in.
Working capacity	30 tons	Heating surface	1465 sq. ft.
Graining volume (%working capacity)	... 21%	Centre well diam.	... 4 ft.

Date	Boiling Time (hours)	Massecuite Temperature			Cooling Time (hours)	Massecuite		Final Molasses	
		on dropping °C.	after cooling °C.	after reheating °C.		Brix	App. Pty.	Brix	Gravity Purity
2.10.56	3.5	—	36	—	80	98.5	57.5	90.9	40.6
3.10.56	4.0	67	34	—	85	98.7	50.0	91.7	40.0
4.10.56	5.5	72	31	—	118	99.0	51.4	89.1	41.4
9.10.56	3.0	68	35	—	84	98.2	52.4	89.9	40.4
20.10 56	5.0	70	30	—	80	98.7	50.5	93.8	49.3
Average	4.20	69	33	—	89	98.6	52.4	91.1	40.3

Table 45. Coil Vacuum Pan by F. Tardieu

Diameter	... 12 ft.	Number of coils	7
Working height	... 5 ft.	Length of coils .. .	100 ft.
Working capacity	25 tons	Diam. of coils .. .	5 in.
Graining volume (%working capacity)	... 20%	Heating surface	915 sq. ft.

Date	Boiling Time (hours)	Massecuite Temperature			Cooling Time (hours)	Massecuite		Final Molasses	
		on dropping °C.	after cooling °C.	after reheating °C.		Brix	App. Pty.	Brix	Gravity Purity
6 10.56	8.0	74	30	—	108	99.8	52 1	89.6	41.4
8.10.56	7 5	70	32	—	78	98.5	51.7	90.1	38.9
9.10.56	8.3	69	35	—	80	98.2	50.3	91.4	39.8
10.10.56	7.7	70	30	—	112	98.7	54.2	90.4	40.2
19.10.56	8.5	69	30	—	82	98.5	51.2	91.2	39.9
Average	8.00	70	31	—	92	98.7	51.9	90 5	40.0

As may be seen from table 39, in all the three factories where comparisons were made, the use of calandria instead of coil pans for the boiling of C-massecuites has resulted in a reduction of boiling time of over 50% on the average, without affecting the exhaustion of the final molasses. It will also be noted from this table that massecuites of brixes as high as those obtaining in the coil pans were easily boiled in the calandria pans.

It appears then that under the conditions prevailing in Mauritius calandria pans are as good as coil pans for boiling C-massecuites. However calandria pans offer the advantage of boiling twice as fast as coil pans. Hence, assuming that a calandria and a coil pan of the same capacity represent the same capital expenditure, the calandria pan may be considered to cost only half as much as the coil pan since the output of the former is twice that of the latter per unit time. As a matter of fact, even if this time factor is ignored, a coil pan of modern design, say, forty tons capacity costs at present twenty-five to thirty thousand rupees more than a calandria pan of modern design too.

Another advantage of calandria pans is that, for the same output, only half as much floor space is required as with coil pans. Finally, it should not be forgotten that the cost of repairs and maintenance of calandria pans is considerably less than that of coil pans.

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2. WATER-COOLED VERSUS AIR-COOLED CRYSTALLIZERS FOR THE COOLING OF C-MASSECUITES

J. DUPONT DE R. ST. ANTOINE

In spite of the modern recognized practice of using crystallizers fitted with cooling elements for the rapid cooling of C-massecuites, most of the C-crystallizers found in Mauritius sugar factories are still of the ribbon-type, air-cooled.

Several factory engineers, however, have fitted C-crystallizers with static cooling coils, but in only a few cases is full advantage derived from this system as the massecuite is allowed to stay some two days or more in the crystallizers prior to cooling water being admitted through the cooling coils, the explanation given being that the difference in temperature between the massecuite, on dropping, and the cooling water is so great that false grain soon appears in the crystallizers. This may sometimes be true early during the crop when the temperature of the cooling water is below 20° C. and coincides with a massecuite temperature higher than normal.

Although it has not been possible during the present study to check on the accuracy of the above-mentioned explanation, it is nevertheless felt that the danger of false grain formation as a result of rapid cooling (in crystallizers fitted with static cooling coils) with water at or slightly below 20° C. has been somewhat overemphasized. It is believed that in most cases the appearance of false grain is caused by insufficient crystal content of the massecuite on dropping.

More recently, the C-crystallizers of two factories have all been equipped with Blanchard cooling coils, whilst on several others some only of the C-crystallizers have been fitted with the coils.

Since it had been decided to carry out a series of comparisons on the boiling of C-massecuites in coil and in calandria vacuum pans during the 1956 crop, it was believed it would be useful to follow up this work with a study of the rapid versus the slow cooling of C-massecuites in crystallizers.

The object of the present study then is:

(1) to stress the importance of and encourage a practice which is already well-known in Mauritius, namely the rapid cooling of C-massecuites, but which is as yet followed in only a few of our factories;

(2) to compare crystallizers fitted with Blanchard cooling coils with ordinary static cooling coil crystallizers for the rapid cooling of C-massecuites.

Three series of comparisons were made during the crop, and the average results obtained in each case are given below.

(a). Factories: LABOURDONNAIS AND BEAU PLAN

The characteristics of the C-crystallizers used at these two factories and the average results obtained are given in tables 46 to 49. For the purpose of the present study, air cooling of the massecuites was effected in crystallizers fitted with cooling coils through which water was not made to circulate.

Table 46.

	Labourdonnais	Beau Plan
Type of crystallizer	Cylindrical	U—shaped
Length, ft.	26	17
Diameter, ft.	5.5	7.0
Useful capacity, cu. ft.	550	700
Rotation speed of paddles, r.p.m.	1.4	1.0
Number of cooling coils	19	10
Length of each coil, ft.	61	102
Spacing of coils, in.	15	18
Effective cooling surface, sq. ft.	285	267
Sq. ft. cooling surface/cu. ft. massecuite	0.52	0.38

Table 47.

	Labourdonnais		Beau Plan	
Crystallizer	Air-Cooled	Water-Cooled	Air-Cooled	Water-Cooled
Number of tests	15	15	9	11
Test period	8.10 to 15.11.56	8.10 to 15.11.56	11.10 to 9.11.56	15.10 to 8.11.56
Brix massecuite	99.5	99.3	100.5	100.6
Apparent purity massecuite	56.4	56.5	55.7	56.2
Crystal content on dropping*	—	—	32.1	32.0
Massecuite temperature on dropping, °C.	69.0	69.1	67.0	67.0
Cooling water temperature, °C.	—	27.5	—	27.4
Massecuite temperature after cooling, °C.	31.0	31.5	32.7	32.8
Massecuite temperature after reheating, °C.	—	—	50.6	50.9
Average cooling time, hours	102	41	96	35
Minimum cooling time, hours	78	23	62	17
Maximum cooling time, hours	125	62	125	53
Per cent reduction in cooling time	—	60	—	64
Crystal content after cooling*	—	—	34.9	36.2
Brix final molasses	96.4	96.2	94.4	93.6
Gravity purity final molasses	35.8	35.9	37.5	37.0

* *Expressed per 100 parts total solids in massecuite and calculated from gravity purities, the molasses being obtained both on dropping and after cooling, through the use of a laboratory centrifuge.*

As may be seen from table 47, it was possible both at Labourdonnais and at Beau Plan to reduce the cooling time by sixty and sixty-four per cent, respectively, by using crystallizers fitted with cooling coils instead of ordinary air-cooled crystallizers. This cooling time may even be reduced further, if necessary; as a matter of fact in the course of the study several massecuites were cooled in less than 24 hours, as shown above under "minimum cooling time".

As this table also indicates, rapid cooling has no ill effect on the exhaustion of the molasses. At Beau Plan there is a slight indication that the water-cooled massecuites yielded better molasses than the air-cooled ones, but the difference is probably not significant. It may be concluded therefore, that the average cooling time of C-massecuites in Mauritius may be considerably reduced through the use of crystallizers fitted with cooling coils. Following the adoption of such a practice, the total number of the C-crystallizers will also be greatly reduced in our sugar factories where row upon row of these crystallizers will soon be a feature of the past.

(b). Factory: MON TRESOR

At this factory a series of tests were carried out to compare Blanchard crystallizers with static-coil crystallizers for the cooling of C-massecuites. The characteristics of these crystallizers and the average results obtained are given in tables 48 and 49.

Table 48.

	Blanchard	Static Coil
Length, ft.	18	18
Diameter, ft.	8	8
Useful capacity, cu. ft.	800	800
Rotation speed, r. p. m.	0.33	0.75
Number of cooling coils	—	9
Length of each coil, ft.	—	115
Spacing of coils, in.	—	24
Effective cooling surface, sq. ft.	440	240
Sq. ft. cooling surface/cu. ft. massecuite	0.55	0.30

Because of the conditions prevailing at Mon Trésor during the test period, it was unfortunately not possible, both with the Blanchard and with the static coil crystallizers, to cool the massecuites in the minimum time. Hence the efficiency of each type of crystallizer cannot be assessed.

The massecuites from the Blanchard crystallizers have yielded, on the average, molasses of lower purity than those from the static coil crystallizers. However it must be pointed out that the ratio sq. ft. cooling surface / cu. ft. capacity of the latter is only 0.30 whilst that of the former is 0.55. Anyhow, the number of tests made is too small to enable one to conclude one way or the other. In this connection it must be pointed out that different authors have drawn different conclusions on the influence of the Blanchard elements on the purity of the final molasses. Gundu Rao and Shastry (1), for example, claim a lower molasses purity (apparent) of 2-3 units as a result of the use of Fletcher-Blanchard heat exchange units at Ravalgaon Fundora and Rubio (2), on the other hand, conclude that the use of the Blanchard crystallizers does not result in a better exhaustion of the molasses, though it does cause a more rapid exhaustion.

Table 49.

	Blanchard	Static Coil
Number of Tests	7	7
Test period	11.9.–25.9.56	11.9.–25.9.56
Brix massecuite	99.9	100.4
Apparent purity massecuite	49.0	49.4
Crystal content on dropping*	27.7	29.1
Massecuite temperature on dropping, °C.	69.6	69.9
Cooling water temperature, °C.	24.0	24.0
Massecuite temperature after cooling, °C.	28.9	28.1
Massecuite temperature after reheating, °C.	39.7	39.9
Average cooling time, hours	50	100
Minimum cooling time, hours	27	44
Maximum cooling time, hours	85	157
Crystal content after cooling*	33.0	34.9
Brix final molasses	92.1	91.7
Gravity purity final molasses	35.1	36.2

* *See footnote on page 86.*

Mechanically speaking, there is no doubt that Blanchard cooling coils are a better proposition than static coils; their use results in a better distribution of the cooling surface and a better mixing of the massecuite, and has solved the troublesome problem of leaks so common with static coils. Their major drawback, however, is their high cost.

In conclusion, I should like to express my gratitude to the estate managers, factory engineers and chemists of the factories in which the tests were carried out.

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3. CHEMICAL CONTROL NOTES

J. DUPONT DE R. ST. ANTOINE AND J. P. LAMUSSE

THE WEIGHING OF MIXED JUICE

One of the most important data required by the factory chemist for working out correctly his control figures is the accurate weight of mixed juice. This is the reason why sugar factories in Mauritius have been equipped with automatic Maxwell Boulogne juice scales, and there is no doubt that since then a more accurate chemical control is exercised.

Unfortunately, however, juice scales are not always fool proof, and unless they are carefully repaired and maintained as well as regularly checked they are liable to record inaccurate weights.

Following a recommendation made by Bouvet (1), after a visit to South Africa in 1955, Médine factory installed a platform scale for the purpose of checking, several times daily, the juice weights measured by the Maxwell Boulogne, and three other factories soon followed the lead. In one of these factories (A), where the Maxwell Boulogne had been the source of particular trouble during the past crops, the platform scale is used for reweighing each and every dump of the Maxwell Boulogne. Detailed results obtained at this factory during three consecutive weeks are reproduced below (table 50).

Table 50.

Date	No. of Dumps (2500 kg. each)	Juice Weight, kg. Maxwell Boulogne	Juice Weight, kg. Platform Scale	Difference kg.
17.9.56.	853	2,132,500	2,151,840	— 19,340
18.9.56.	800	2,000,000	1,989,350	+ 10,650
19.9.56.	928	2,320,000	2,356,430	— 36,430
20.9.56.	899	2,247,500	2,257,850	— 10,350
21.9.56.	920	2,300,000	2,309,800	— 9,800
22.9.56.	901	2,252,500	2,280,210	— 27,710
Total	5301	13,252,500	13,345,480	— 92,980
Average (kg./dump)		—	—	— 17.5
24.9.56.	872	2,180,000	2,188,960	— 8,960
25.9.56.	892	2,230,000	2,255,900	— 25,900
26.9.56.	901	2,252,500	2,251,940	+ 1,260
27.9.56.	896	2,240,000	2,260,080	— 20,080
28.9.56.	791	1,977,500	1,985,800	— 8,300
Total	4352	10,880,000	10,941,980	— 61,980
Average (kg./dump)		—	—	— 14.2
1.10.56.	627	1,567,500	1,575,920	— 8,420
2.10.56.	881	2,202,500	2,203,740	— 1,240
3.10.56.	894	2,235,000	2,233,820	+ 1,180
4.10.56.	873	2,182,500	2,203,660	— 21,160
5.10.56.	897	2,242,500	2,243,570	— 1,070
6.10.56.	892	2,230,000	2,237,240	— 7,240
Total	5064	13,660,000	13,697,950	— 37,950
Average (kg./dump)		—	—	— 7.5

The above figures indicate clearly that in the case of this factory the Maxwell Boulogne scale was working very erratically and unreliably.

In another factory (B), a platform scale was installed prior to the last crop not only for checking the Maxwell Boulogne scale several times daily during crushing, but also for checking the latter's tare once a week. Thus on every Sunday the platform scale was first checked with standard weights, following which several water dumps of the Maxwell Boulogne were re-weighed on the platform scale. The averages of these weights are given below, and are compared with the averages of the juice check weights obtained during the week (table 51)

A lesser number of similar checks were made on two other factories, (C) and (D), and the following results were obtained (table 52).

Thus in the case of factories (B) and (C) the Maxwell Boulogne scales were working correctly whereas in factory (D) some discrepancy could be observed.

Table 51.

Date	Average Water Weight Measured by Platform Scale on Sunday, kg.	Average Juice Check Weight of Platform Scale During Week, kg	Difference kg.
26.8.56.	1500	1500	Nil
2.9.56	1500	1500	Nil
9.9.56.	1520	1520	Nil
17.9.56.	1500	1520	+ 20
24.9.56.	1510	1520	+ 10
8.10.56.	1520	1520	Nil
15.10.56.	1520	1520	Nil
22.10.56.	1520	1520	Nil
29.10.56.	1520	1520	Nil
10.11.56.	1500	1500	Nil
17.11.56.	1520	1520	Nil
Average	1512	1515	+ 3

Table 52.

Factory		Average Water Weight Measured by Platform Scale on Sunday, kg.	Average Juice Check Weight of Platform Scale During Week, kg.	Difference kg.
C		2504	2498	— 6
C		2499	2502	+ 3
C		2438	2440	+ 2
C		2388	2391	— 3
C	Average	2457	2458	— 1
D		2495	2483	— 12
D		2500	2497	— 3
D		2527	2495	— 32
D	Average	2507	2492	— 15

The main conclusions to be drawn from the above tables are:

(1) The feeling voiced by some chemists that Maxwell Boulogne scales cannot be properly tared on Sundays because of the absence of factory vibrations on those days does not seem correct, in many cases at least. It should be stressed, however, that for proper taring the scale should be allowed to dump several times and the average weight of the dumps — excluding the first one — should be taken as the tare. Further, the pipe feeding the scale should be of such a diameter that it takes about the same time to fill the scale with water as is taken with juice.

(2) Because of several reasons, the most important of which are lack of proper repairs and maintenance and inadequate facilities for proper taring, Maxwell Boulogne scales may easily go wrong. And if that does happen, even for a week or two in between two checks, the chemist cannot know about it in any precise way. Hence, so long as Maxwell Boulogne scales will be used in our factories, the chemical control of several of the latter will lack accuracy unless check scales are installed.

It should be pointed out here that there is a tendency in Mauritius to consider that a constant value of the ratio Brix of absolute juice/Brix of first expressed juice is an indication of good chemical control and therefore of a correct weight of mixed juice. This ratio was worked out during the past crop for each factory every week and in no case was a straight line relationship obtained on plotting B_A/B_1 against the corresponding weeks. The best curve obtained is shown in fig. 28 under factory (A) whereas that for factory (B) is typical of the curves of most factories.

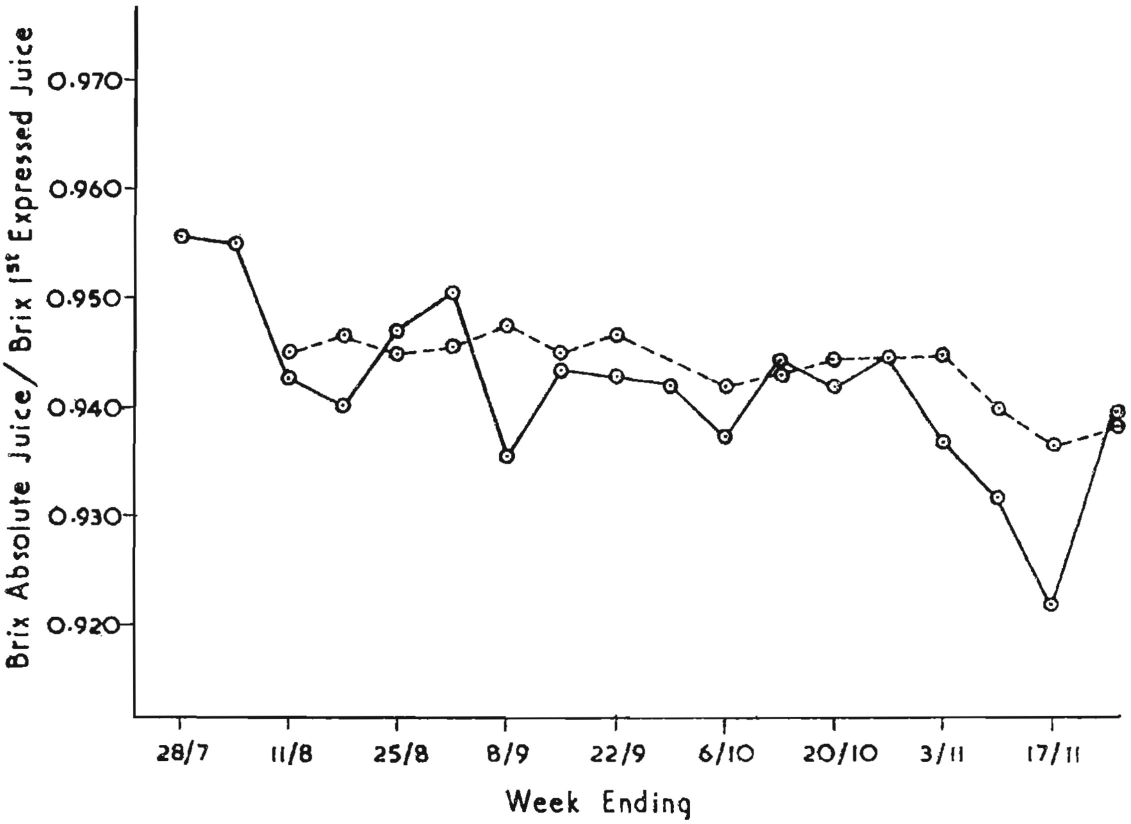

Fig. 28. Weekly variations in the ratio B_A/B_1 for factory A (broken line) and for factory B (plain line).

It should not be forgotten that, apart from the weight of mixed juice, those of cane and of imbibition water affect markedly the value of the ratio B_A/B_1. The influence of the weights of mixed juice and of imbibition water under average conditions are shown graphically in figs. 29 and 30; that of the weight of cane has not been included since it is of the same magnitude as that of mixed juice.

Weekly variations in the ratio B_A/B_1 cannot therefore be taken as being necessarily due to errors in the weight of mixed juice or even as an indication that the chemical control of a factory is unreliable, as a small error in the weight of imbibition water strongly affects the value of B_A/B_1 whilst it has no appreciable effect on key control figures.

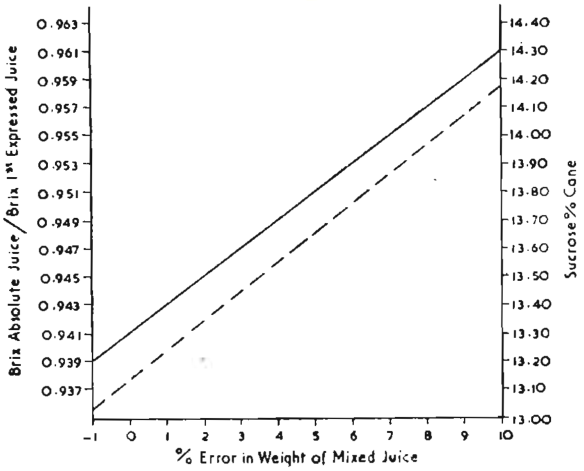

Fig. 29. Influence of weight of mixed juice on ratio BA/B1 (plain line) and on sucrose content (broken line).

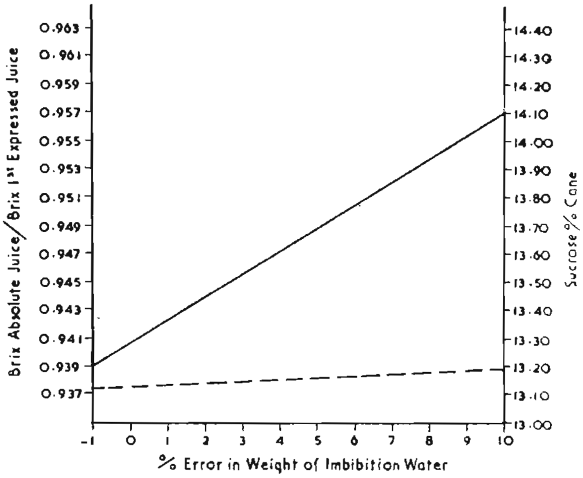

Fig. 30. Influence of weight of imbibition water on ratio BA/B1 (plain line) and on sucrose content (broken line).

REFERENCE

1. Bouvet, P. E. — (1956). Report on a mission in South Africa in 1955, Rev. Agr. Maur., *35* (1), 14—20.

Table II. ***Area under sugar cane in thousand arpents[1], 1952 — 1956. The first column gives the total area under sugar cane, the others the area reaped for milling.***

Year	Island	Area reaped					
		Island	West	North	East	South	Centre
1952	174.30	165.36	7.82	47.24	36.68	51.91	21.83
1953	176.88	167.10	8.41	47.10	37.19	52.70	21.70
1954	178.82	168.44	8.55	48.06	37.37	52.40	22.06
1955	180.05	168.59	8.82	47.80	36.90	52.78	21.86
1956(2)	181.00	169.66	8.35	48.14	37.62	53.51	22.04

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] 1952 — 1956.***

Crop Year	No. of factories operating	Av. Pol	Island	West	North	East	South	Centre
1952	27	98.5	467.8	25.92	127.75	98.43	152.14	63.06
1953	27	98.6	512.1	31.09	150.09	104.98	158.25	67.64
1954	27	98.6	498.6	28.12	140.29	98.05	163.31	68.83
1955	26	98.6	533.3	31.52	148.39	103.40	173.96	76.07
1956(2)	26	98.6	571.9	30.90	166.90	110.10	187.50	76.50

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(2) 1952 — 1956.

	1952	1953	1954	1955	1956(1)
ISLAND					
Millers	30.9	32.5	31.0	31.0	31.9
Planters	19.5	23.1	20.4	19.7	20.7
Average	24.8	27.8	25.4	25.1	26.0
WEST					
Millers	31.7	37.1	32.2	34.3	32.2
Planters	25.0	30.0	25.4	24.3	25.9
Average	27.3	32.4	27.7	27.8	28.2
NORTH					
Millers	30.1	34.9	30.9	29.0	32.2
Planters	18.9	26.3	21.4	20.5	22.2
Average	22.6	29.1	24.6	23.5	25.5
EAST					
Millers	33.6	34.1	29.9	31.8	31.6
Planters	19.5	22.2	18.4	17.3	17.9
Average	24.2	26.3	22.6	22.5	22.8
SOUTH					
Millers	30.7	30.9	31.1	30.7	31.7
Planters	19.6	20.5	20.4	19.7	21.2
Average	26.8	27.3	27.5	27.2	28.1
CENTRE					
Millers	29.3	30.9	31.5	32.4	32.7
Planters	18.4	21.2	19.4	19.7	18.6
Average	24.3	26.7	26.2	27.1	26.9

NOTE : (1) *Provisional figures*
(2) *to convert in metric tons/acre* x *0.959*
,, *long tons/acre* x *0.945*
,, *short tons/acre* x *1.058*
,, *metric tons/hectare* x *2.370*

Table V. Average sugar manufactured % cane[2] 1952 — 1956.

Crop year	Island	West	North	East	South	Centre
1952	11.42	12.12	11.94	11.08	10.94	11.92
1953	11.03	11.39	10.93	10.74	10.99	11.77
1954	11.65	11.87	11.88	11.62	11.35	11.89
1955	12.61	12.85	13.22	12.43	12.11	12.83
1956(1)	12.94	13.12	13.57	12.82	12.46	12.90

NOTE: (1) *Provisional figures.*

(2) *To convert into tons cane per ton sugar manufactured: divide 100 by above percentage.*

Table VI. Tons sugar manufactured per arpent reaped, 1952 — 1956.

	Island	West	North	East	South	Centre
1952	2.83	3.31	2.71	2.68	2 93	2.89
1953	3.06	3.70	3.19	2.82	3.00	3.12
1954	2.96	3.29	2.92	2.62	3.12	3.12
1955	3.17	3.57	3.10	2.80	3.30	3.48
1956(1)	3.37	3.70	3.47	2.93	3.50	3.47

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

NOTE: To convert into millimetres, multiply by 25.4

Table VIII. Highest wind speed during one hour in miles[2]. Average over Mauritius.

Crop Year	1949	1950	1951	1952	1953	1954	1955	1956
NOVEMBER	—	21	17	24	18	18	14	16
DECEMBER	18	16	24	21	15	16	15	17
JANUARY	27	26	21	22	18	28	13	20
FEBRUARY	20	24	20	25	15	15	*34*(1)	16
MARCH	20	17	18	25	15	15	29	19
APRIL	18	21	17	22	20	16	16	17
MAY	20	19	20	24	22	22	19	18
JUNE	24	20	23	25	23	20	22	17
JULY	21	23	21	20	24	16	17	15
AUGUST	18	19	24	25	24	23	20	14
SEPTEMBER	20	21	21	21	20	19	19	17
OCTOBER	18	19	20	20	19	20	14	18

NOTE : (1) *Cyclonic wind above 30 miles per hour.*

(2) *To convert into : knots multiply by 0.87.*
kilometres/hr. multiply by 1.61.
metres/sec. multiply by 0.45.

Table IX. Variety trend in Mauritius 1930 — 1955.

% Area Cultivated

	Tannas	M. P. seedlings 55 and 131	Demerara seedlings DK/74, D 109 D 130, RP/6 RP/8	POJ. 2878	BH. 10/12	M. 134/32	Other M. seedlings	Ebène 1/37	B. 3337, 34104, 37161, 37172
1930	57	10	16	—	2	—	—	—	—
1935	48	7	16	1	15	—	—	—	—
1940	29	1	1	5	40	2	5	—	—
1944	5	—	—	2	27	37	7	—	—
1950	—	—	—	—	—	91	6	—	—
1953	—	—	—	—	—	83	5	8	—
1954	—	—	—	—	—	83	5	10	2
1955	—	—	—	—	—	74	5	15	6

Table X. Area planted under different cane varieties on sugar estates in 1956.

Varieties	Island		West		North		East		South		Centre	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
M. 134/32	2068	16.3	—	—	1074	49.4	152	7.4	802	14.7	40	1.7
M. 134/32 (white)	544	4.3	140	20.6	75	3.4	195	9.6	134	2.5	—	—
M. 112/34	283	2.2	—	—	93	4.3	30	1.4	98	1.8	62	2.6
M. 147/44	1775	14.0	277	40.8	147	6.8	337	16.6	628	11.5	386	16.1
M. 31/45	1137	9.0	—	—	31	1.4	172	8.4	741	13.6	193	8.0
Ebène 1/37	3621	28.5	51	7.6	186	8.6	719	35.4	1196	22.0	1469	61.4
B. 3337	941	7.4	—	—	13	0.6	60	2.9	662	12.2	206	8.6
B. 34104	363	2.9	78	11.5	17	0.8	12	0.5	256	4.7	—	—
B. 37161	1070	8.4	112	16.6	318	14.7	154	7.6	468	8.6	18	0.8
B. 37172	814	6.4	16	2.4	181	8.4	189	9.3	416	7.6	12	0.5
Other varieties	90	0.6	4	0.5	34	1.6	9	0.4	37	0.8	6	0.3
Total	12706	—	678	—	2169	—	2029	—	5438	—	2392	—

Table XI. 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

NOTE: *The weight of cane produced on estates in 1956 was: virgins 388,556 tons; ratoons 2,509,924 tons.*

Table XII. Average yields of virgin and ratoon canes on estates. Tons per arpent. A, 1947-1955; B, 1956.

	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
Virgin	35.2	36.0	41.6	40.0	34.2	38.9	39.2	38.0	33.8	33.7	33.9	36.0
1st Ratoon	32.6	35.4	34.9	37.5	33.3	34.4	34.0	34.9	31.9	35.4	31.9	35.4
2nd "	30.8	33.2	32.6	34.0	31.9	33.9	33.4	32.4	30.2	33.2	29.5	33.2
3rd "	29.1	31.6	31.3	29.1	29.3	32.3	31.0	31.8	28.2	31.6	27.6	31.6
4th "	28.6	30.2	30.5	28.8	27.6	31.1	29.0	30.7	29.0	30.2	27.3	30.2
5th "	27.9	30.2	29.6	30.2	26.9	32.0	27.4	29.0	28.6	30.2	27.4	30.2
6th "	28.0	28.6	—	29.5	26.6	28.4	—	27.9	28.4	28.6	—	28.6

Table XIII. List of Crosses

REDUIT AND PAMPLEMOUSSES 1956.

CROSS		Number of crosses made	Number of seedlings obtained	CROSS		Number of crosses made	Number of seedlings obtained
B. 3337	x M. 147/44	1	170	B. 37161	x M. 31/45	2	4
B. 3439	x M. 147/44	3	1120	,,	x M. 142/49	3	5
B. 3439	x P. R. 905	2	8	,,	x P.O.J. 2878	5	9
B. 34104	x Co. 419	3	12	,,	x P.O.J. 2940	1	0
,,	x Co. 421	2	0	,,	x P.R. 905	1	4
,,	x D. 109	6	209	,,	x R. 397	1	0
,,	x D. K. 74	3	202	B. 37172	x Ebène 1/37	5	2
,,	x Ebène 1/37	6	1035	,,	x M. 147/44	4	187
,,	x M. 171/30	4	1	,,	x M. 31/45	1	0
,,	x M. 63/39	3	840	,,	x P.O.J. 2961	3	19
,,	x M. 213/40	4	2134	,,	x S.C. 12/4	2	1
,,	x M. 147/44	4	1050	B. 41227	x Co. 421	2	0
,,	x M. 12/49	1	0	,,	x M. 147/44	2	79
,,	x M. 142/49	2	1500	,,	x S.C. 12/4	2	141
,,	x M. 381/51	1	0	Black Tanna	x M. 147/44	2	9
,,	x M. 716/51	1	4	Co. 281	x Co. 290	3	340
,,	x P.O.J. 2878	7	517	,,	x Co. 419	4	4
,,	x P.O.J. 2961	2	11	,,	x D. 109	4	9
,,	x P.O.J. 3016	2	0	,,	x Ebène 1/37	1	0
,,	x P.R. 905	3	113	,,	x M. 63/39	4	965
B. 37161	x Co. 419	1	0	Co. 421	x B. 34104	2	0
,,	x D. 109	4	33	,,	x B. 41227	2	0
,,	x Ebène 1/37	7	141	,,	x C.P. 36 - 105	1	0
,,	x M. 63/39	6	53	,,	x M. 63/39	1	0
,,	x M. 147/44	5	10	,,	x M. 423/41	2	330

CROSS		Number of crosses made	Number of seedlings obtained
Co. 421	x P.O.J. 2878	2	71
,,	x P.O.J. 2940	2	0
,,	x P.O.J. 2961	2	0
C. P. 34 - 120	x Co. 421	2	320
Ebène 1/37	x B. 34104	2	1470
,,	x B. 37172	2	190
,,	x B. 4098	2	0
,,	x Co. 419	2	51
,,	x Co. 421	1	0
,,	x M. 213/40	3	501
,,	x M. 147/44	6	144
,,	x M. 31/45	2	1
,,	x M. 142/49	3	500
,,	x M. 381/51	2	0
,,	x M. 716/51	2	11
,,	x P.O.J. 2940	2	130
Ebène 1/37	x P.O.J. 2961	1	0
,,	x R. 397	1	0
Fotiogo	x M. 63/39	1	0
M. 134/32	x B. 34104	4	932
,,	x B. 37172	2	2
,,	x B. 4098	6	54
,,	x Co. 419	4	26
,,	x Co. 421	1	0
,,	x Ebène 1/37	6	3070

CROSS		Number of crosses made	Number of seedlings obtained
M. 134/32	x M. 336	2	70
,,	x M. 171/30	1	0
,,	x M. 147/44	6	640
,,	x M. 31/45	5	452
,,	x M. 381/51	1	0
,,	x M. 716/51	1	36
,,	x P.O.J. 2940	3	138
,,	x P.O.J. 2961	4	365
M. 112/34	x B. 34104	2	204
,,	x B. 37172	3	0
,,	x B. 4098	2	10
,,	x Co. 421	1	0
,,	x M. 336	3	14
,,	x M. 63/39	2	0
,,	x M. 147/44	8	889
,,	x M. 31/45	1	70
,,	x M. 12/49	3	0
,,	x M. 142/49	2	1900
,,	x M. 381/51	1	0
,,	x M. 164/53	2	8
,,	x P.O.J. 2940	2	28
,,	x P.O.J. 3016	1	350
M. 241/40	x B. 34104	2	11
,,	x B. 4098	2	0
,,	x Co. 421	4	0

CROSS		Number of crosses made	Number of seedlings obtained	CROSS		Number of crosses made	Number of seedlings obtained
M 241/40	x D. 109	2	6	M. 63/47	x Co. 290	3	0
,,	x Ebène 1/37	5	250	,,	x Ebène 1/37	2	4
,,	x M. 147/44	4	1600	,,	x M. 147/44	1	60
,,	x P.O.J. 2878	4	87	M. 93/48	x S.C. 12/4	1	0
,,	x P.O.J. 2940	1	25	M. 99/48	x Ebène 1/37	1	0
,,	x P.O.J. 3016	2	140	M. 142/49	x B. 34104	1	22
M. 311/41	x M. 147/44	2	6	,,	x Ebène 1/37	1	53
M. 377/41	x B. 41227	1	0	,,	x S.C. 12/4	1	47
,,	x M. 147/44	1	0	M. 379/51	x M. 381/51	1	0
M. 129/43	x B. 34104	1	4	M. 381/51	x M. 379/51	1	0
,,	x B. 37172	2	8	M. 716/51	x selfed	1	2
,,	x Ebène 1/37	2	110	M. 167/53	x M. 164/53	1	0
,,	x M. 171/30	2	31	Mapou Perlée	x B. 41227	2	0
,,	x M. 147/44	4	139	,,	x Co. 421	2	0
,,	x M. 716/51	1	50	,,	x Glagah Kletak	2	60
,,	x P.O.J. 3016	1	15	,,	x M. 147/44	1	25
,,	x R. 397	1	0	M. L. 3-18	x B. 37172	1	3
M. 147/44	x selfed	1	12	,,	x Co. 290	1	18
M. 24/47	x B. 34104	1	20	,,	x D. 109	1	0
,,	x B. 37172	1	11	,,	x Ebène 1/37	1	110
,,	x Co. 421	1	12	,,	x M. 147/44	2	280
,,	x Ebène 1/37	2	52	,,	x R. 366	1	0
,,	x M. 147/44	2	33	55 P.	x M. 147/44	1	0
,,	x P.O.J. 2940	3	124	131 P.	x Ebène 1/37	2	90
,,	x S.C. 12/4	2	154	,,	x M. 147/44	4	860

CROSS	Number of crosses made	Number of seedlings obtained
Pindar x D. 109	1	0
,, x Ebène 1/37	1	0
,, x M. 147/44	2	0
P.O.J. 2878 x B. 34104	6	98
,, x Co. 290	2	700
,, x D. 109	2	0
,, x D. K. 74	7	1040
P.O.J. 2878 x M. 171/30	5	27
,, x M. 147/44	4	710
S. Spontaneum (*Glagah Kletak*) *selfed*	1	0
S. Spontaneum (*Glagah Kletak*) x *S. robustum*	2	331
S. robustum x *S. spontaneum* (*Glagah Kletak*)	2	1025
Total	390	32383

Table XVII. 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	9,200	43,682	227	109	2,236