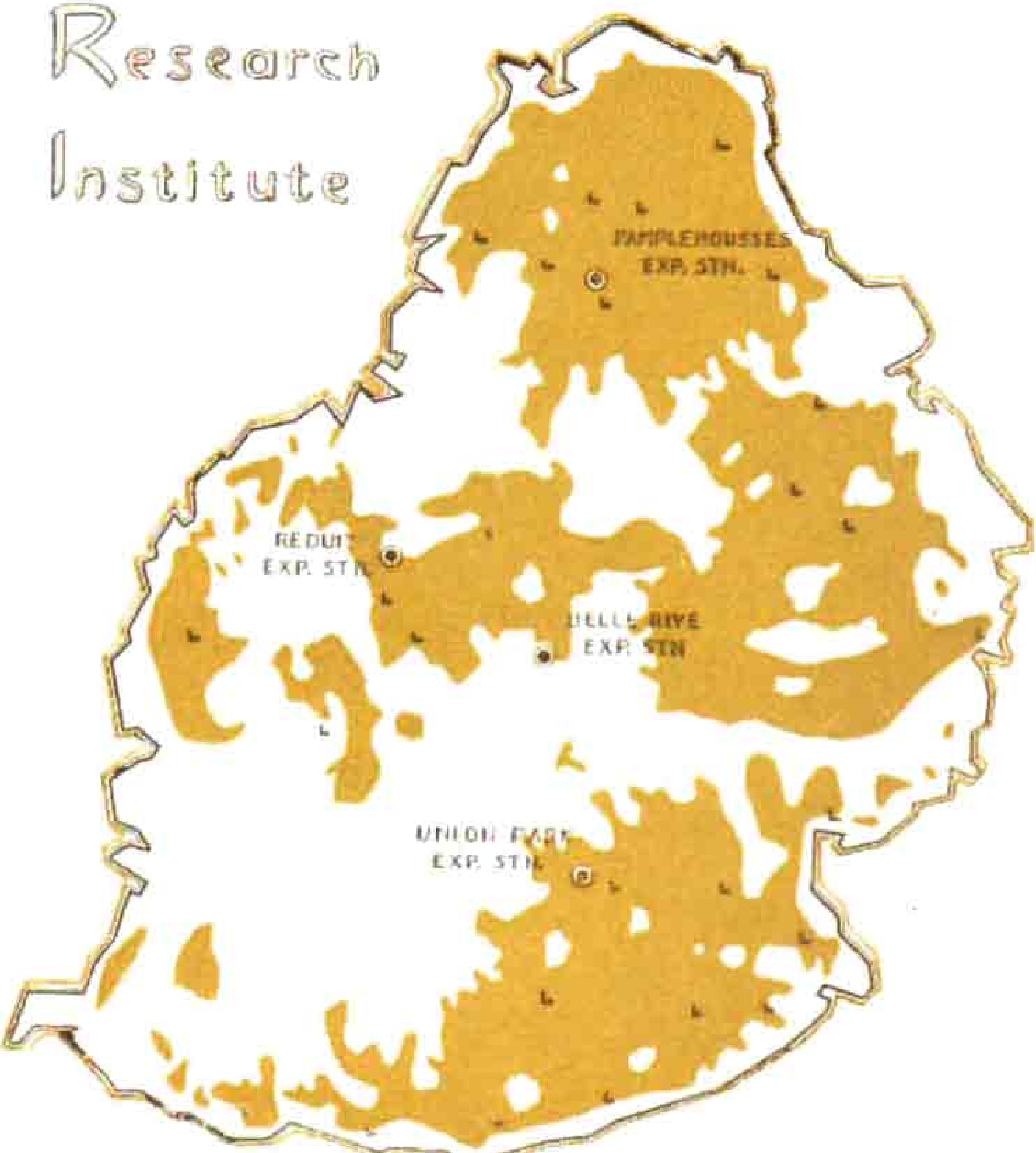
Mauritius Sugar Industry Research Institute



Annual Report 1955

Mauritius Sugar Industry Research Institute

ANNUAL REPORT 1955

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CONTENTS

APPENDIX

CORRIGENDA

ANNUAL REPORT, 1954

Page 36, table 11, line 4 *read* Clay $<2\mu$ % *instead of* Clay <2 per %.

" 38, " 12 *read* $p=0.05$ *instead of* $p=0.01$.

" 39, " 14 " " " "

" 41, " 16 " " " "

" 43, line 7, *read* 1947 *instead of* 1937.

" 44, "Excess" column *read* $>$ *instead of* $<$

" " "optimum" column *read* 110—90 *instead of* 110—30

" " line 20 *read* amount of phosphatic and potassic fertilizers *instead of* amount of potassic fertilizer.

" 45, line 32, *read* oven *instead of* over.

" " " 39 " 50 cc. " 500 cc.

" " " 18 " P_2O_5 " P_2O_2.

" " " 30 " 10 cc. " 100 cc.

" 59, table 25, " 50 lbs Sodium chlorate *instead of* 20 lbs.

" 79, line 16 " M. 76/39 *instead of* M. 73/39.

" 80 " 1 " B. 37161 " B. 37261.

" 86 " 13 " R. 331 " Co. 312.

" " " 17 " Co. 911 " Co. 991.

" " " 20 " Co. 213 " Co. 312.

MEMBERS EXECUTIVE BOARD

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and the senior staff of the Research Institute.

Co-opted member :

Mr. J. R. Williams, Entomologist, Department of Agriculture

STAFF LIST

Director	P. O. Wiehe, M.Sc., A.R.C.S., F.L.S.
Agronomist	Pierre Halais, Dip.Agr. (Maur.)
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Geneticist	Vacant
Plant Pathologist ...	R. Antoine, B.Sc., A.R.C.S., Dip.Ag.Sc. (Cantab.), Dip.Agr. (Maur.)
Entomologist	Vacant
Sugar Technologist ...	J. Dupont de R. St. Antoine, B.S., Dip.Agr. (Maur.)
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Centre	L. P. Noël, Dip.Agr. (Maur.) *i/c Belle Rive Experiment Station*
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Botany	P. Rouillard
Chemistry ...	L. C. Figon
Foliar Diagnosis	Mrs. G. Caine
Pathology ...	C. Ricaud
Sugar Technology ...	F. Le Guen
Secretary-Accountant ...	P. G. du Mée
Clerks	Mrs. A. d'Espagnac
	Mrs. A. Baissac

REVENUE & EXPENDITURE ACCOUNT

Year ended 30th June 1955

RUNNING COSTS, MAINTENANCE & DEVELOPMENT OF STATIONS & LABORATORIES	505,268.33	CESS ON SUGAR EXPORTED ...	953,014.26
PERSONAL EMOLUMENTS & PENSION FUND CONTRIBUTIONS ...	292,480.03	MISCELLANEOUS RECEIPTS ...	34,873.64
FEES — BOARD MEMBERS, AUDITORS & LEGAL ADVISER	4,710.—		
GENERAL OFFICE & LIBRARY EXPENSES	66,280.52		
INTEREST ON LOAN	19,166.66		
LEAVE & MISSIONS FUND ...	50,000.—		
PHYTALUS CESS	47,650.69		
	985,556.23		
Excess of revenue over expenditure for the period carried to accumulated funds ...	2,331.67		
Rs.	987,887.90	Rs.	987,887.90

BALANCE SHEET

as at 30th June 1955

ACCUMULATED FUNDS	470,584.52	FIXED ASSETS — (at cost less depreciation & amounts written off)	
RESERVE FUND	44,030.97	Land & Buildings	678,680.05
LOAN FROM A.M A S. LTD ...	500,000.—	Equipement & Furniture: Laboratories, houses & offices	300.—
SUNDRY CREDITORS & ACCRUED EXPENSES	2,083.33	Agricultural Machinery & Vehicles ...	25,300.—
RETENTION MONEY ON COMPLETED BUILDINGS	19,200.—	CURRENT ASSETS :	
		Sundry Debtors	27,632.84
		Cash on deposit	126,350.—
		Cash at banks & on hand ...	177,635.93
Rs	1,035,898.82	Rs.	1,035,898.82

AUDITORS' REPORT

We have examined the Books and Accounts of the Institute for the year ended 30th. June, 1955 and have obtained all the information and explanations we have required

In our opinion 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, 1955, 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) P. O WIEHE *Director*

Port-Louis,
Mauritius,
26th August, 1955

(sd) P. R. C. du MÉE
C.A. (S.A.), A.S.A.A.
P. P. DUBRUEL, de CHAZAL,
du MÉE & Co.,
Auditors.

REPORT OF THE CHAIRMAN
EXECUTIVE BOARD, 1955

THE Executive Board of the Sugar Research Institute continued its activities in 1955 with the same membership as that of the original Board except that Mr. M. N. Lucie-Smith became the Government representative on the Board, on his appointment to the post of Director of Agriculture.

The Board held 16 meetings during the year and visited the four experimental stations and laboratories on several occasions. Satisfactory progress was made in developing the Institute according to the plan laid down in 1954.

ESTABLISHMENT

New appointments made during the year included:

Sugar Technologist: J. Dupont de Rivalz St. Antoine, B. S., formerly Lecturer in Sugar Technology at the Mauritius Agricultural College and Acting Registrar, Central Board.

Laboratory Assistants: Foliar Diagnosis: Mrs. G. Caine.
Plant Pathology: C. Ricaud.
Sugar Technology: F. Le Guen.

Mr. R. Antoine, who had been appointed during the previous year, assumed duty as Plant Pathologist on the 1st March, and Mr. C. Ricaud, Laboratory Assistant on the 1st November.

Mr. G. Mazery was promoted to the post of Senior Field Officer.

The Board acting in full agreement with the Department of Agriculture decided that research work in sugar manufacture would begin in January 1956 when the Department proposes to close down its division of Sugar Technology. The opening of this new section is yet another step towards the completion of the accepted structure of the Institute.

Pursuing the policy that it is essential that its officers should benefit from scientific contacts overseas, the Board approved the following study tours:

Messrs. P. O. Wiehe, Director and R. Antoine, Pathologist, made a tour of the sugarcane areas of Australia and Fiji from April to May.

Mr. E. Rochecouste, Botanist, devoted several weeks of his overseas leave to visit agricultural research organizations in the U. K., France and Germany.

Mr. S. M. Feillafé, Assistant Chemist, was granted study leave of four months' duration which he spent mostly at Rothamsted Experimental Station and the Macaulay Institute for Soil Research.

The Board is grateful to the Director of Agriculture, for having accepted that Mr. G. Orian, M. B. E., Plant Pathologist in his department, should visit the cane area of the Eastern coast of Madagascar to report on the Fiji disease situation there.

The Board recorded with appreciation the distinction of Officier du Mérite Agricole, conferred by the French Government on Mr. P. Halais, Agronomist.

DEVELOPMENT

Much of the building programme initiated the previous year was concluded in 1955. At the headquarters of the Institute at Réduit, the new Chemistry and Foliar Diagnosis laboratories as well as an experimental cane mill were opened in July. An adjoining house was exchanged with Government for another elsewhere belonging to the Institute, and serves at present as quarters for the Chemist. The Board approved the construction of permanent buildings to be used as workshop and stores. The Government Bacteriological Laboratory, however, which was promised to the Institute three years ago and was to house its main services appears to be no nearer delivery this year than last year. Although the Board appreciates the difficulties of Government with regard to its building programme, it cannot but deplore the fact that this delay should impose upon the staff both of the Institute and of the Department of Agriculture the handicap of having to work under conditions of great congestion. Meanwhile, a new greenhouse has been built at Pamplemousses experimental station while at Belle Rive and Union Park stations the officers' quarters, offices and camps have been occupied during the year, and a portion of land adjoining the Belle Rive Office has been acquired.

Deeds witnessing the leases of experimental land which had already been occupied at Réduit and Pamplemousses were prepared and signed during the year.

FINANCE

At the close of the second financial year of the Institute the accumulated funds amounted to Rs. 470,504.52. As foreseen in the previous report fairly extensive capital expenditure was incurred in connection with land and buildings, machinery and vehicles.

Expenditure on laboratory equipment, library and office furniture was written off and a large amount was also spent on the development of experimental stations. In addition to this, adequate depreciation on land and buildings, vehicles and machinery was provided and the special reserve for leave and missions and miscellaneous funds was maintained at approximately the same level.

In view of the narrow margin between revenue and current expenditure the Board unanimously recommended to H. E. the Governor that the cess on exported sugar should be increased from Rs. 2.00 per ton to Rs. 2.50, a figure which represents approximately 0.5% of an average crop value at ruling sugar prices. This recommendation was approved and the cess increased accordingly with effect from the 15th December 1955.

The revenue and expenditure account and balance sheet of the Institute appear on page (6) of this report.

This report only aims at summarising the administrative and financial background against which the real work of the Institute has proceeded. This work itself is dealt with in the rest of this report and my colleagues of the Board and myself merely wish to put on record our full appreciation of the singlemindedness, enthusiasm and zeal which have throughout inspired our Director and his staff, to whom we express our thanks.

A. Esnouf (?) [signature]

CHAIRMAN.

31st December, 1955.

INTRODUCTION

THE development of the Sugar Industry Research Institute during the second year of its existence, has been summarised in the Chairman's report. Some progress was made towards the completion of the accepted structure of the Institute, by the creation of a cane pathology section, which started to operate in March, while steps were taken to begin investigations in sugar technology early in 1956. The new chemistry and foliar diagnosis and cane analysis laboratories were opened in July and the sugar technology laboratories were completed. The building programme started at the three experimental stations in 1954 was also concluded during the year. It is hoped that the Medical Department buildings at Réduit, which Government has agreed to sell to the Institute some years ago, will be handed over in the not too distant future. The present accommodation of the administration, plant breeding, botany, pathology and agricultural sections are sadly deficient and work on cane pests cannot be initiated under present conditions.

The same pattern has been followed in the presentation of the 1955 report as in the previous year. The work of the Institute is briefly reviewed in this Introduction which also includes comments of general interest on factors which have influenced the record sugar production of 1955, the importance of ratooning in the economy of sugarcane cultivation in Mauritius and the cane variety position. The results of current investigations are reported separately by individual members of the staff. Important data on the sugar industry of the island are published in tabular form in an appendix. The descriptive account (table I) grouping essential information on sugar sectors of the island, which was published last year, has been slightly modified but retained in order to facilitate reference. Corrections have been made to the statistical information where necessary, and in this connection the assistance of officials of the Chamber of Agriculture, is gratefully acknowledged. New tables include: the yield of commercial sugar per arpent (Table VI); data on the evolution of the 1955 crop (Table VII); cane quality in 1955 (Table VIII); the proportion of ratoon canes in the total crop (Table XIV); the yield of plant and ratoon canes (Table XV).

THE 1955 SUGAR CROP

Cane yields in 1955 averaged 25.3 tons per arpent, with 12.61% extraction (7.5 tons cane per ton sugar), equivalent to 3.2 tons of sugar per arpent resulting in the record production of 533,000 tons sugar at 98.6 pol.

A brief analysis of prevailing climatic conditions during the year (see Table IX & X) reveals adequate rainfall early in the growing season from November to mid December 1954, followed by a short drought until the end of February when a cyclone of moderate intensity accompanied by heavy precipitation passed to within 60 miles of the North West of Mauritius. Thereafter, humidity conditions were excellent until the close of the growing season in June. Rainfall was normal or below normal throughout the harvest season. Thus, apart from a short unfavourable period during the year, climatic factors have been almost at an optimal level for cane growth and maturity. This fact explains the exceptionally high sugar yields obtained on local standards, and should not be overlooked when assessing the potential average sugar production of the colony. Other factors which have probably contributed significantly to the high sugar content of the cane include: the paucity of arrows with consequent high juice purity late in the season; cool night temperatures during harvest; an increasing proportion of sweeter varieties, chiefly Ebène 1/37; cleaner canes; improved mill efficiency and regular supply of canes at the factory.

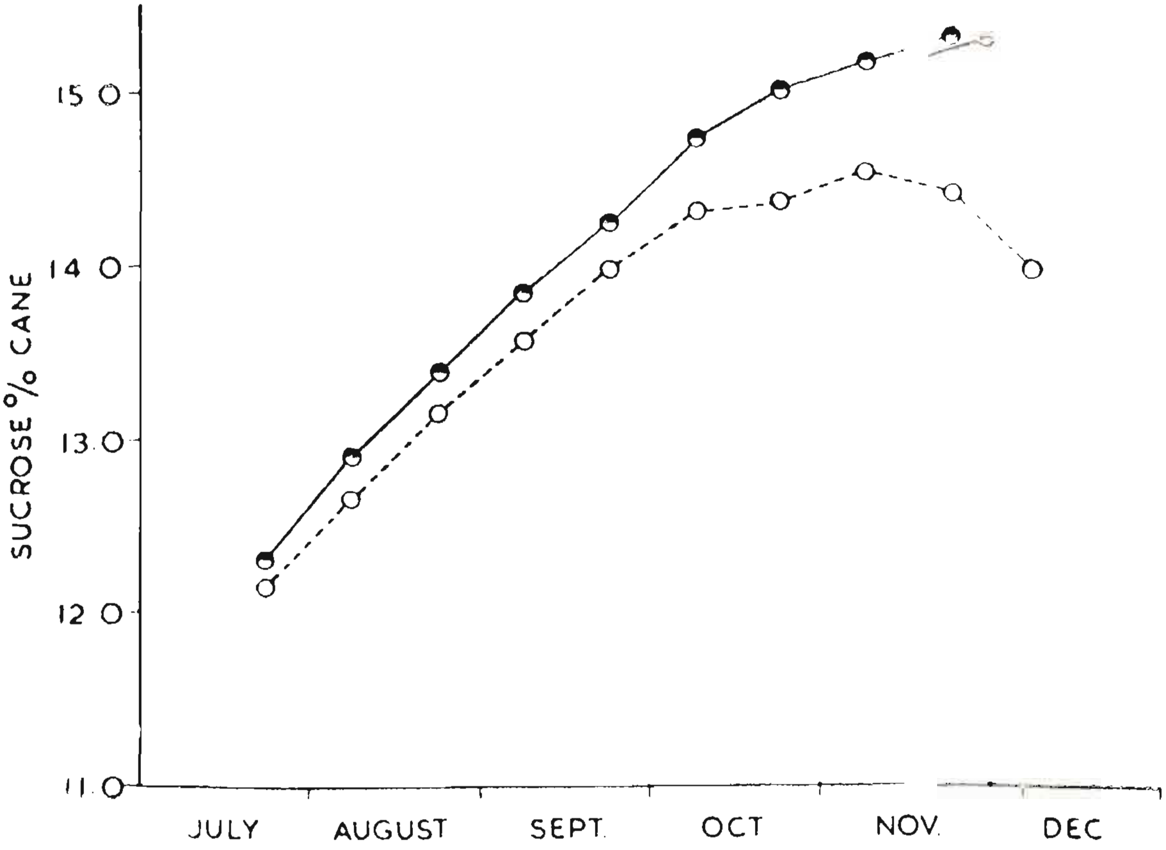


Fig. 1. Fortnightly variations in sucrose % cane for all Mauritius factories. Plain line, 1955 crop; broken line, average 1947—1954.

The maturation curve published in fig. 1 shows the departure of sucrose % cane from normal at fortnightly intervals. It will be observed that in spite of the consistenly higher level attained in 1955, the need for early maturing varieties is as pressing as ever.

It is interesting to note that estimation of the sugar crop at different times during the year using Halais' equation published in the 1954 report, was as follows:

March 1955 — 472,000 tons, with an estimated average extraction of 11.9% cane and 5% cyclone reduction.

July 1955 — 526,000 tons, with the same estimated extraction.

The calculated sugar production based upon rainfall excesses and deficits during the year amounts to 538,000 tons, a positive discrepancy of less than 1%, which adds further evidence that rainfall is the dominating factor in sugar production under conditions prevailing in Mauritius.

RATOONING OF SUGARCANE IN MAURITIUS

A feature of the Mauritius Sugar Industry is the practice of long ratooning on all cane lands of the island. This tendency has been further intensified during the last 10 years by the cultivation of more vigorous varieties. For example, in the days when noble canes such as Tannas and B.H. 10/12 were cultivated, the decrease in yield from virgin to last cultivated ratoons varied from 10 to 15 tons per arpent, 4th ratoons being uprooted after harvest. Under present conditions the average drop in yield is 8 tons from virgin to 6th ratoon, representing an approximate decrease of 1 ton of cane per arpent per year (fig. 2)

Normal practice in Mauritius is to replant after six ratoons, but on many estates, individual fields are allowed to produce up to 9 or 10 ratoons with yields often exceeding 3.5 tons of sugar per arpent per year. The economic significance of these figures is obvious and it was considered important, therefore, to collect accurate data on the relative yields and production of virgin and ratoon canes obtained on estates during the last 7 years. The information obtained is summarised in tables XIV, and XV. Reference to these data indicates that the proportion of ratoon canes harvested has increased gradually during the last six years until 1952 when equilibrium was reached at an approximate level of 88% of the total cane weight produced by estates. At present, the area under ratoon canes amounts to approximately 90% of the reaped acreage.

The implications of any disturbing factor affecting yield and duration of ratooning is of particular importance in cane agriculture in Mauritius and explains the emphasis which the Research Institute places in its research programme on such investigations as correct nutrition, ratoon stunting disease, improved cultivation methods and selection of seedlings with high ratooning capacity.

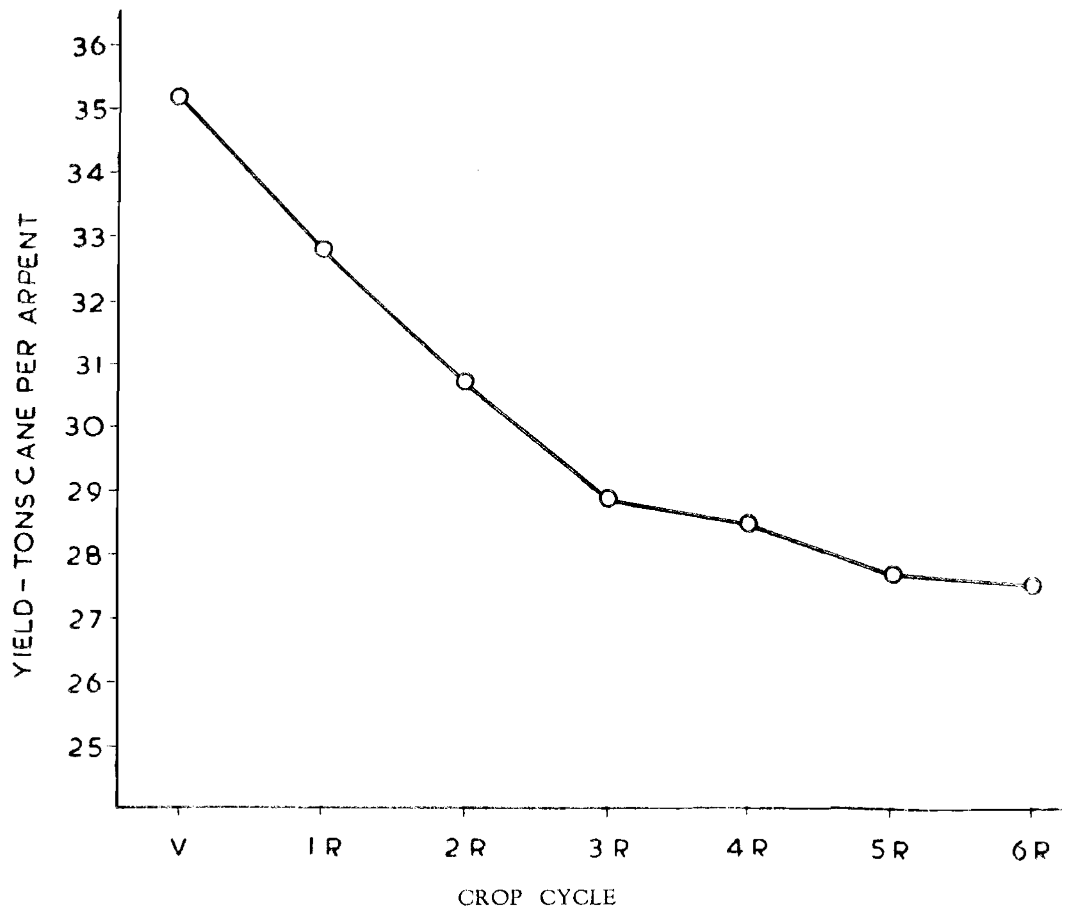


Fig. 2 Average yield of plant and ratoon canes for all estates of Mauritius, 1947—1954. The relative proportions were ; V. 16% ; 1st R, 17% ; 2nd R, 16% ; 3rd R, 14% ; 4th R, 15% ; 5th R, 12% ; 6th R, 10%.

THE CANE VARIETY POSITION

Although M. 134/32 still remains the dominant variety under cultivation in Mauritius it has now passed its peak of popularity, and for the first time in the last ten years a larger acreage has been planted with another variety (Fig. 3). Ebène 1/37 is probably one of the sweetest canes grown in Mauritius; it is also a vigorous variety. Serious faults on the other hand are: its inability to resist drought, susceptibility to chlorotic streak, and susceptibility to wind damage. In this connection, caution should be exercised in order to avoid disappointment in the event of a serious cyclone. It should also be pointed out that Ebène 1/37 does not possess the adaptability of M. 134/32 to various environmental conditions and performs well only in regions receiving more than 80″ of rain per annum.

The area under new plantations in different sectors of the island is shown in Table XIII and in fig. 3, from which it may be observed that the trend recorded in 1954 has been accentuated, M. 134/32 has lost ground in all sectors, particularly in the East, South and Centre but still remains the more important variety in the North. A large area of white M. 134/32 was planted in the West where this mutant has the reputation of being superior to the parent cane. Ebène 1/37 is being propagated intensively in the East and Centre where it occupies over 50% of the area under virgin canes. The Barbados varieties 3337, 37161 and 37172 are gaining ground; they cover at present approximately 5% of the total

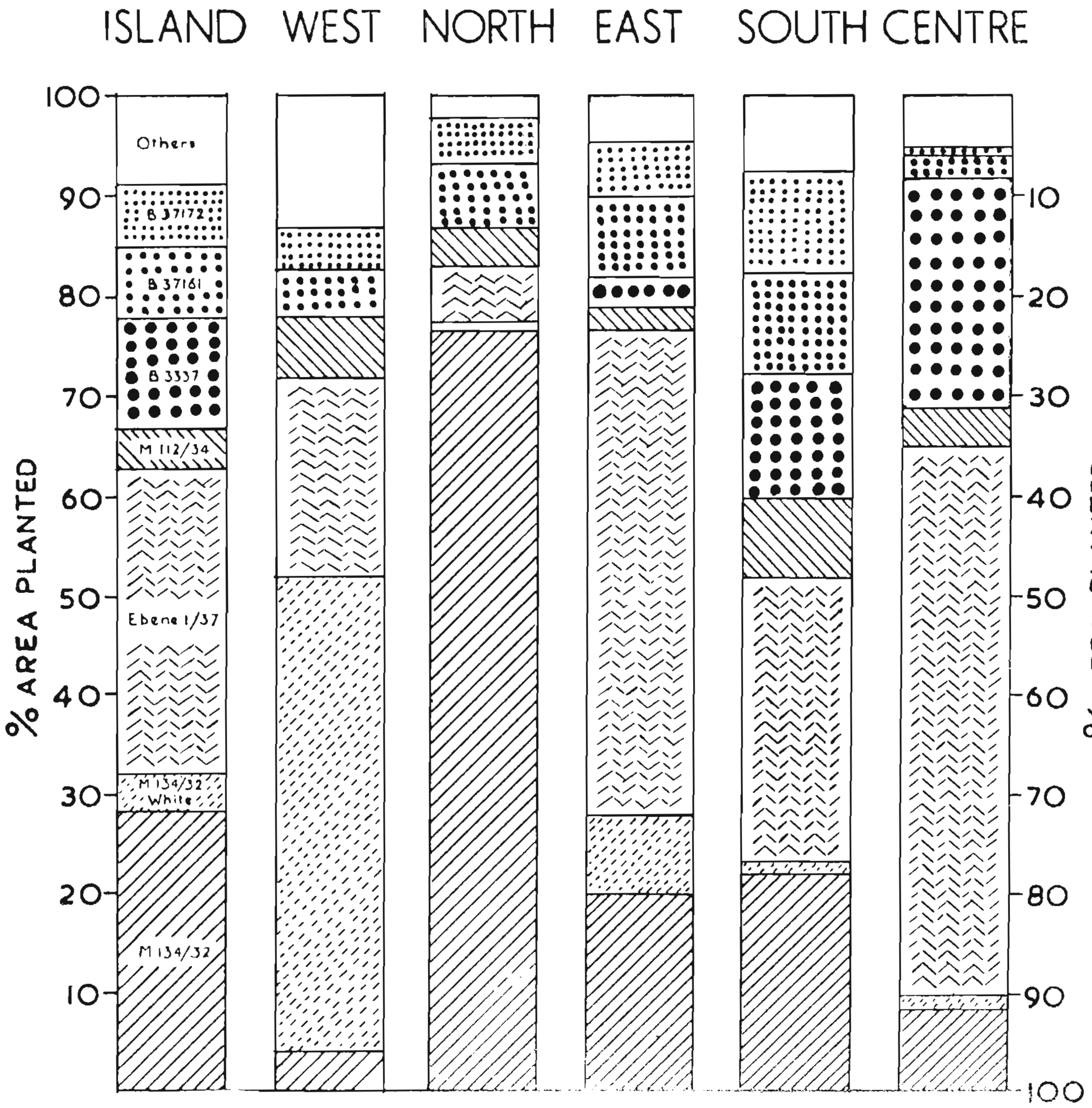


Fig. 3. Percentage area planted in different cane varieties in 1955.

cane area cultivated by estates. Generally speaking these three varieties have produced good sugar yields per arpent but higher sucrose content was expected in most localities from B. 37161 and B. 37172.

The Cane Release Committee met in December under the chairmanship of the Director of the Institute and recommended that the varieties M. 147/44, M. 31/45 and B. 34104 should be released for commercial cultivation. Both M. 147/44 and M. 31/45 are vigorous varieties which have performed remarkably well under diverse environmental conditions. The former however, is richer and is very likely an early maturer, while M. 31/45 matures in mid or late season. The release of B. 34104 is recommended with caution on account of its susceptibility to leaf scald in other countries. No cases of natural infection however, have been recorded so far in Mauritius Regarding M. 129/43, the Committee decided that it was desirable to obtain additional data before considering its release. The pedigree of Mauritius seedlings is shown in fig. 5.

The crossing programme in 1955 was disappointing, on account of both lack of arrows and low pollen fertility, factors which are discussed by the Plant Breeder elsewhere in this report. Approximately 30,000 seedlings were planted at the four experimental stations. Seedlings produced in 1954 were cut in August, for selection in first ratoon at 11 or 12 months in 1956. 336 varieties were selected amongst 1953 seedlings and planted in " first selection trials", while 48 seedlings have passed from first selection trials to pre-release trials on estates in 1956. In order to eliminate rapidly varieties selected from original seedling populations, but which lose vigour when planted from cuttings, multiplication plots with a control variety are now included as an intermediate phase in the selection programme, between original seedlings and first selection trials. There are at present 91 varieties of the 1946 to 1951 series undergoing test in replicated block trials on estates.

By arrangement with the Department of Agriculture it has been agreed that greater use will be made of the available space in the quarantine house, by planting imported cuttings in smaller containers. Thirteen varieties will probably be released from quarantine early in 1956, when twenty other varieties, mostly breeding canes, will be introduced.

NUTRITION AND SOILS

Work on a detailed study of cane juice composition has started and some preliminary results pertaining to the Nitrogen and amino acid contents are presented in this report. These investigations are of both physiological and technological interest as it seems to be recognised that small though the amounts of nitrogeneous material are in cane juice, they are capable of exerting a profound effect not only on clarification but even in the recovery of sucrose from molasses.

An analysis of data obtained from 84 trials laid down by the Centre Agronomique du Nord between 1947 and 1949 in the sub-humid and humid zones have revealed that it is more economical to apply nitrogenous fertilizers in one single dose as early as possible after harvest. The same quantity of fertilizers applied in two doses, or applied later in the season have produced slightly lower yields but the differences do not appear to be significant.

The problem of phosphate fertilization in Mauritius is reviewed. Experiments which were laid down in 1954 to test the efficacy of various forms of phosphatic fertilizers on deficient soils have been harvested The first results obtained, indicate that superphosphate is superior to the various froms of tricalcium phosphates used in these trials.

Routine foliar diagnosis was made on approximately 8,000 leaf samples derived from estates and planters lands, and recommendations were issued on the desirable phosphate and potash fertilization for large cultural units within each factory area. Data obtained from small planters' fields were communicated to the extension service of the Department of Agriculture. It should be clearly stated that in order to derive the greatest economic benefit from the services of the foliar diagnosis laboratory of the Institute, individual fertilization programmes should be adjusted to take into account proved excesses or deficiencies of a particular element.

Studies on the variability of foliar diagnosis data have established the margins within which the number of leaf samples should be taken for different purposes.

In view of the response in yield to lime treatment of gravelly soils, reported last year, samples of these soils have been taken to compare their chemical characteristics with those of the free soils which do not respond to lime treatment. Data on pH and buffer curves are presented.

The results obtained from a number of experiments on earthing-up and cultivation of interlines are discussed. They show that earthing up is probably a sound cultural practice in localities receiving more than 80″ of rain annually, particularly on free soils. In this connection it should be pointed out, that real earthing-up can hardly be practiced on gravelly soils such as those of the "Mapou" and "Plaisance" types. These data also indicate that in spite of the large number of replications it is extremely difficult to draw precise conclusions from experiments on cultural operations because of the small differences in yield which they may cause.

CANE DISEASES

The activities of the newly created pathology section of the Institute were concentrated chiefly on ratoon stunting and chlorotic streak which are two major diseases affecting the local sugar industry at present.

Concerning ratoon stunting disease, evidence obtained so far, indicates that M. 134/32 is commercially resistant in the sub-humid and humid regions of the island but may be seriously affected by the virus in super-humid localities. The varietal changes taking place in the latter areas are largely conditioned by the disease. The effect of environment on the severity of ratoon stunting disease is clearly marked in Mauritius and has been experimentally demonstrated. Identical trials laid down at the three experimental stations have shown yield reductions varying fron 30% at Union Park (125″ rainfall) to 6% at Réduit (55″ rainfall). It is interesting to note that infected planting material derived from a severely stunted field of the wet zone in 1954, produced a normal crop at Réduit Experiment Station in 1955, in spite of the presence of obvious internal stem symptoms.

The disastrous effects of ratoon stunting disease on a susceptible variety was well illustrated in a pre-release variety trial which included Co. 419 in three localities. Yields in virgins were at the same level as the control variety, but declined rapidly in the first and second ratoons, the four replications in each experiment showing a similar decrease. Because of distinct internal stem symptoms observed in these plots, failure of Co. 419 has been ascribed to extreme susceptibility to stunting disease. The progressive decline in yields is illustrated in fig. 4.

Difficulties are often experienced in the correct diagnosis of ratoon stunting disease on account of internal stem symptoms which are evanescent, and seasonal in some varieties or may be very faint in others. With a view to improve the accuracy in diagnosis, investigations were initiated on the chemical composition of healthy and diseased stalks of the same variety by chromatography. These studies are still in progress; the results obtained to date justify that further attention should be given to this problem.

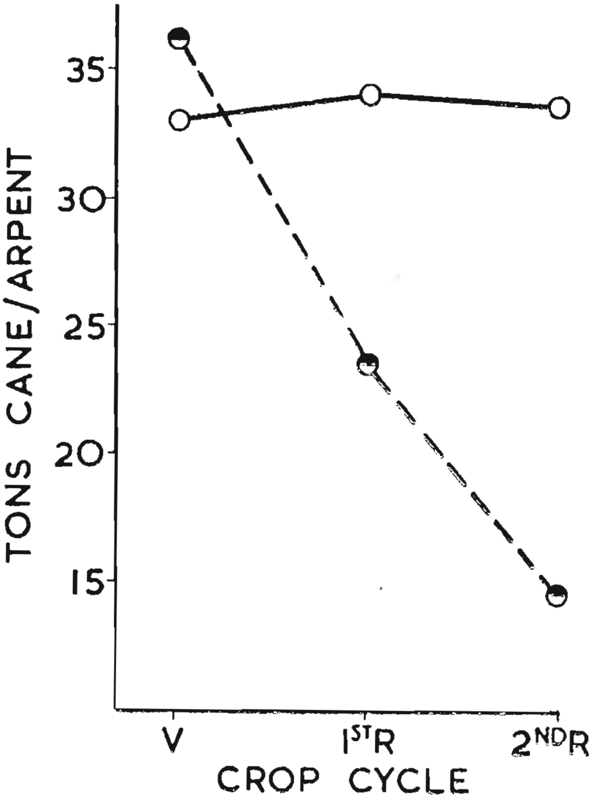


Fig. 4. Effect of ratoon stunting disease on yield of Co. 419 (broken line). The control variety (plain line) was M. 134/32.

In order to prevent the spread of the disease, planters were advised on the desirability of knife sterilisation during harvest, particularly when cutters pass from one field to another and at the conclusion of the day's work. Harvesting fields of new varieties with sterile knives is of particular importance. Immersion of knives for 15 seconds in a solution of "Zephirol", a product marketed under several trade names, is recommended. The solution should contain 0.5% of the active substance, benzalkonium chloride.

Heat treatment of cuttings to control ratoon stunting disease has received special attention and is discussed separately.

Several aspects of chlorotic streak disease are described in detail by the Pathologist. Mention should be made here of an experiment designed to elucidate factors concerned with secondary infection. Heat treated setts were planted in 6 x 6 latin squares at two months' intervals at Belle Rive and Union Park Experimental Stations where environmental conditions are favourable to the disease. No symptoms were present in one of the trials ten months after planting, while in the other, symptoms began to appear after three months, thus indicating the presence of an active transmission agent at one of the experimental sites.

Susceptibility ratings on the basis of abundance of symptoms, have shown that the three dominant varieties of the super-humid zone could be classified in increasing order of resistance thus: Ebène 1/37, M. 134/32, B. 3337.

The sugar community of Mauritius has perforce to take a keen interest in the progress of the Fiji disease eradication campaign in Madagascar and as mentioned in the Chairman's report, the Director of Agriculture kindly consented that Mr. G. Orian, M. B. E., Plant Pathologist of his Department, should visit the infected localities of the East Coast of Madagascar while on leave. Mr. Orian's report indicates that while a large number of diseased stools (160,000) were destroyed during the period August 1954 to April 1955 there are still many difficulties to be overcome before complete eradication can be foreseen.

The Fiji disease situation in Madagascar was discussed at the 5th Conference of the Comité de Collaboration Agricole Maurice—Réunion—Madagascar and suggestions were made concerning a suitable layout for testing the resistance of varieties, based on information obtained in Australia and Fiji. Several varieties grown commercially in Mauritius have been included in this trial.

Experiments were also carried out locally on the use of TCA for destroying cane stools with a view to assess the efficacy of a chemical agent for the elimination of diseased stools.

CANE PESTS

The Entomologist of the Department of Agriculture again cooperated with the Institute during the year, and his assistance was of the greatest help.

The white grub, *Clemora smithi* (Arr.) and the spotted moth borer, *Proceras sacchariphagus* Boj. are undoubtedly the two most important pests of sugarcane in Mauritius. Several heavy localised infestations of the former occurred during the year causing appreciable injury to cane growth. Attempts are being made to evolve an economic method of insecticidal control for this pest and promising early results have been obtained from experiments with chlordane applied to the soil before beetle emergence. Severe attacks of the spotted or stalk borer are recurrent in sub-humid regions where its effect upon sugar yields is insidious and needs further study, particularly in relation to cane variety. Parasitic insects which attack species allied to the spotted borer are being introduced from abroad.

Perkinsiella saccharicida Kirk., the sugarcane leafhopper, is a known vector of Fiji disease in countries where this disease occurs. The insect itself is not reported to cause direct injury to cane and, as a result, little is known of its habits in Mauritius. The introduction of Fiji disease into Madagascar in recent years and the threat which this constitutes to Mauritius has, however, given the insect a potential importance and knowledge of its bionomics in the island has become very desirable. Studies to this end have been in progress for the greater part of the year.

Localized outbreaks of the scale insect, *Pulvinaria* sp. (" pou a poche blanche "), occurred towards the end of the year. They are not, however, of a serious nature. The scale has been inconspicious and apparently rare for many decates and the unusually dry weather during October—November upset the high degree of natural control which normally exists.

HOT WATER TREATMENT

Although the majority of cane planters in Mauritius are aware of the objects of different heat treatments on cane setts, there still appears to be some confusion between the " short " and " long " hot water treatments. Consequently, it is deemed of importance to review briefly the aims and objects of the two treatments and the results which may be expected therefrom.

The "*short hot water treatment*" (52° C for 20 minutes) was used as far back as the early twenties in the U. S. A. in an endeavour to control mosaic disease and was then proved to be a powerful stimulant to the germination of cuttings. The method was later adapted to control chlorotic streak in several countries and began to be used on a large scale in

Mauritius in 1953. The beneficial results obtained locally have already been described in the 1954 report, when it was concluded that in all localities of the island where chlorotic streak is prevalent, (i. e. all areas receiving more than 80″ of rain per annum) cuttings should be subjected to the short hot water treatment before planting. In spite of secondary infection which may occur in plantations derived from heat treated setts, the treatment ensures at least that uniform plantations are obtained, often resulting in significantly higher yields.

The "*long hot water treatment*" (50° C for 2 or 3 hours) was evolved and first applied in Queensland. It is used specifically to inactivate the ratoon stunting virus from infected planting material. Treated cuttings are planted in nurseries in which precautions are taken to prevent infection of the growing cane by mechanical means, the nurseries being used as a source of healthy planting material. There is a narrow margin between the time/temperature at which the virus is destroyed and that which sugarcane buds may tolerate. This treatment therefore is more delicate and requires greater precautions than the short hot water treatment in order to be successful. Preliminary observations made in Mauritius in 1954 and 1955 have shown that different cane varieties have a varying tolerance to the long hot water treatment; information was also obtained that temperature control in the tanks used was inadequate, inasmuch as fairly high percentages of ratoon stunting disease symptoms were observed in stools derived from cuttings treated for 2 hours at 50°C. Further, in view of the fact that conflicting reports have appeared in technical literature it has been decided that thorough investigations should be made locally before final recommendations are issued to planters. Consequently, an experimental electrically heated tank of 1/2 ton capacity with thermostatic control has been ordered and will be working shortly at Réduit, to determine such factors as: time/temperature relation to inactivate the virus in different varieties; heat tolerance of varieties; heat tolerance of stalks as affected by age; resistance and susceptibility of different varieties.

An essential corollary to the hot water treatment of cuttings, either short or long, is the protection of setts against pineapple disease as early as possible after treatment. Ideally, a fungicide should be used in solution in the hot water treatment, but as reported previously, prolonged contact of cuttings with hot organic mercurial fungicides, results in rapid deterioration of the latter. Additional experiments carried out in a laboratory tank using different fungicides, confirmed previous results. Until a more stable fungicide is available, it is recommended that cuttings should be immersed for a few seconds in a cold organic mercurial solution immediately after heat treatment and before being taken to the field.

WEED CONTROL

Continuing the investigations reported in 1954, further information was obtained this year on the treatment of fields to be planted and on the treatment of fields before cane emergence. Various chemicals have been used at different concentrations and in different combinations in order to find out the best formulation which should be used under certain specified conditions.

Studies started in 1954 on the chemical treatment of nut grass (' Herbe à oignons '), were continued and useful data have been obtained on the competition of this weed with sugarcane in regard to nutrients uptake.

Preliminary observations on the substituted ureas CMU and PDU were made this year and the results obtained appear promising for superhumid localities.

CANE ANALYSIS

With a view to improve routine methods of cane analyses for agronomic purposes, special equipment consisting of cane cutter, hammer mill and high speed blendor were installed in the new cane analysis laboratory. There is also available a Wiley mill, a high speed saw and a hydraulic press for special studies.

As a result of investigations carried out during the crop it has been found that the combination of cane cutter and hammer mill disintegrates the canes in a satisfactory manner to produce a homogeneous sample from which thorough sucrose extraction can be obtained by means of a large size blendor.

It appears that the accuracy of this direct method for both sucrose and fibre determination is such, that wider application than that originally planned may be anticipated.

GENERAL

Visitors. A large number of visitors called at the Institute during the year and demonstrations of the field and laboratory activities were arranged on several occasions.

It was a great pleasure to welcome H. E. the Governor, Sir Robert Scott, K. C. M. G. and distinguished visitors from abroad, including Mr. J. H. Buzacott, Senior Plant Breeder of the Queensland Bureau of Sugar Experiment Stations who stayed a fortnight in the island in March ; Mr. F. George-Levi, Agronomist at the Madagascar Department of Agriculture who studied experimental methods in use at the Institute during February and March ; Mr. E. P. Keely, C. B. E., of the Ministry of Food ; Mr. L. Marchal, Sugar Expert at the French Economic Ministry ; Sir Philippe Raffray, C. B. E., Q. C., then representative of the Mauritius Chamber of Agriculture in London. In September, the Institute entertained delegates of the Comité de Collaboration Technique Agricole Maurice-Réunion-Madagascar who met in Mauritius for the 5th Annual Conference under the chairmanship of the Director of the Institute. Messrs. J. Riquier, pedologist at the Institut de la Recherche Scientifique in Madagascar and P. Roche, attached to the Soils Division of the Madagascar Department of Agriculture visited the Institute in December and gave valuable advice on a projected soil survey of the island.

Meetings. The Research Advisory Committee met twice during the year to discuss investigations in progress, and to visit the laboratories and experiment stations.

Two series of regional meetings were organised. The first at Réduit and Pamplemousses, the second at Pamplemousses, Belle Rive and Union Park. The subjects were : " Fertilisation problems " by P. Halais and " Ratoon stunting disease " by R. Antoine. The large gathering present on these occasions and the discussions that followed were gratifying evidence of the interest taken in the work of the Institute. On his return from Australia and Fiji, the writer gave a lecture at the Curepipe Town Hall on the sugar industry in these territories.

Sixteen staff meetings were held for the purpose of informal discussions on technical subjects of topical interest and on administrative matters.

Publications. The following publications were issued during the year :

Annual Report for 1954

Bulletins : No. 4. G. Mazery, Report on a visit to the Natal Sugar Belt in 1954.

No. 5. R. Antoine, Observations on sugar cane diseases in Australia and Fiji.

Private Circulation Reports : No. 1. P. O. Wiehe, Observations on a tour of the sugarcane areas of Australia and Fiji, mimeo., 65 pp., 13 figs., Aug. 55.

No. 2. G Orian, The Fiji Disease Situation in Madagascar in 1955, mimeo., 23 pp., 2 figs., Nov. 55.

No. 3. S. M. Feillafé, Report on study leave, mimeo., 14 pp., Nov. 55.

No. 4. E. Rochecouste, Report on a visit to research organizations engaged in chemical weed control, mimeo., 13 pp., No. 55.

Technical Circulars : P. Halais. Etat phosphorique moyen des cannes sur les exploitations sucrières. No. 2., Western, Central and Eastern sectors ; No. 3, Northern sector; No. 4, Southern sector. Etat potassique moyen des cannes sur les exploitations sucrières. No. 2a, Western, Central and Eastern sectors; 3a, Northern sector; 4a, Southern sector.

In addition, bulletins on the evolution of the current sugar crop were prepared and issued at weekly intervals.

STAFF MOVEMENTS

The Director and the Pathologist were absent from 10 April to mid-July on a study tour of the cane areas of Queensland and Fiji. They were invited to attend the Annual Conference of the Queensland Cane Pests and Disease Board which was held at Brisbane on the 21st of April and the 22nd Annual Conference of the Queensland Society of Sugarcane Technologists which met at

Cairns from the 28th April to the 4th May. Observations of interest to the Mauritius sugar industry are recorded in two publications listed above. Mr. Antoine also visited the laboratories of the Commonwealth Scientific and Industrial Research Organization at Canberra, the Waite Institute at Adelaide and the Departments of Agriculture at Melbourne and Perth. I should like to take this opportunity of placing on record my appreciation of the invaluable assistance and kindness shown by all those we met, in particular to the Director of the Queensland Bureau of Sugar Experiment Station and his staff, and to officials of the Colonial Sugar Refining Co. in Australia and Fiji.

The Botanist was granted overseas leave from April to September and spent some time studying recent developments in weed control, particularly at the Department of Agriculture of Oxford University.

During his four months' study leave, the Assistant Chemist devoted particular attention to the study of statistical methods at Rothamsted Experimental Station, soil surveys at the Macaulay Institute and analytical methods at the Agricultural and Horticultural Research Station (Long Ashton).

The Executive Board appointed Messrs. E. Rochecouste, Botanist; J. Dupont, Sugar Technologist and G. Mazery, Senior Field Officer, to represent the Institute at the 9th Congress of the International Society of Sugar Cane Technologists to be held in India early in 1956.

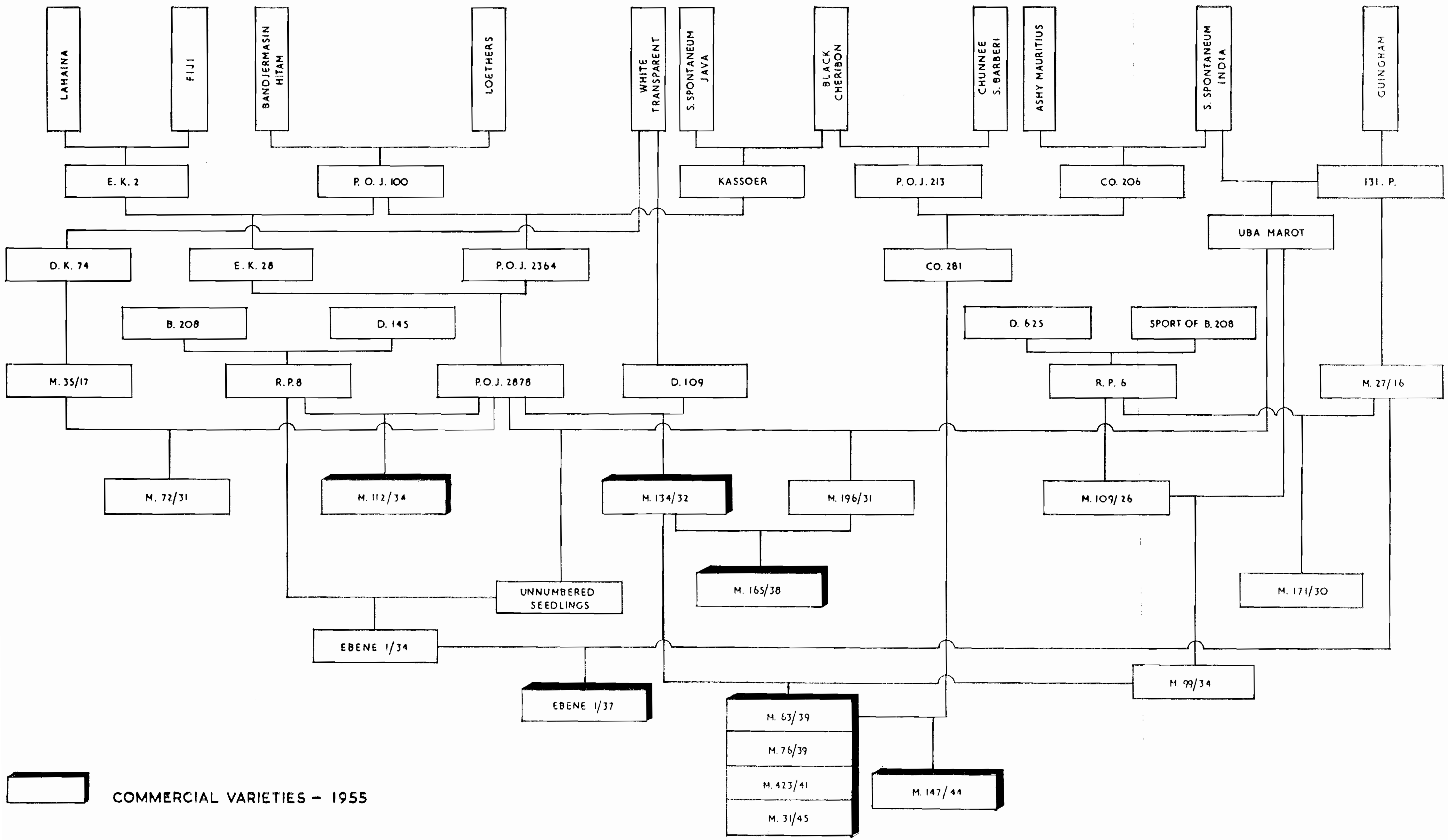
It is a pleasant duty in concluding this brief review of the year's activities to record my deep appreciation of the devotion to duty shown by all members of the staff during the year.

DIRECTOR.

Réduit,

10th January, 1956.

Fig. 5. GENEALOGY OF MAURITIUS SUGAR CANE VARIETIES



CANE BREEDING IN 1955

A. de SORNAY

1. ARROWING & CROSSING

FROM the breeding standpoint, the year under retrospect was one of the worst on record. There was not only a scarcity of arrows in both fields and breeding plots, but fuzz fertility was impaired. The arrowing season was also abnormal from the point of view of flowering dates : the first arrows in certain fields on estates protruded with considerable delay, and the first crosses at Réduit and Pamplemousses Experimental Stations were made at the end of May, that is, about fifteen days later than usual. Observations made towards the middle of October showed that, while there were only old M.134/32 and Ebène 1/37 tassels bearing fuzz in the lowlands, there were still arrows having recently emerged in the uplands, and a certain number of arrows in fairly fresh condition at intermediate altitudes. Anthers of both varieties were collected and examined in the laboratory and revealed interesting features. Quite a number of B.3337 arrows, a late flowering variety, were to be seen on the high plateau in November and were, in all probability, out-of-season arrows.

Crosses made at Réduit and Pamplemousses totaled 181, as against 269 in 1954. Owing to shortage of arrows in the seedling and breeding plots, the crossing programme could not be carried out as contemplated, and only a small proportion of the planned crosses could be effected. Selfing, sib-mating and parent-offspring mating could not be continued on the lines laid down the previous years. The only possible back cross was Ebène 1/37 x M. 716/51 ; the male parent being a self of Ebène 1/37.

New parent varieties used in crossing were R. 366 and R. 397, two varieties from Réunion Island. Co. 421, M. 241/40 (a cane of exceedingly high vigour), M. 381/51 (a B. H. 10/12 derivative) and M. 147/44 were used on a larger scale than in previous years, and have been mated to several parental types. Two arrows of Black Tanna were available in an experimental arrowing plot and have been crossed with P. O. J. 2878. This variety has flowered very little for the past seven or eight years and has produced no seedlings at all. Curiously enough, this year, one of the arrows available, crossed with P. O. J. 2878, yielded eight seedlings, while normally prolific parents gave absolutely sterile fuzz at Réduit, a fact substantiating the view that arrow fertility was abnormal in 1955.

The *Saccharum spontaneum* selfs planted at Réduit in 1954 failed to flower and none of the seedlings could therefore be selfed. Owing to the difficulty of keeping individual seedlings within bounds as to underground shoots, the populations could not be allowed to stand over for next year, nor could they be cut and allowed to ratoon. The following clones have been selected, and three stools of each planted at Réduit in the hope that they will flower in 1956 :

3 clones from Glagah Kloet selfed

3 ,, ,, ,, Kepandjen selfed

2 ,, ,, ,, Passoeroean ,,

All the selected clones diverge considerably from the parent clones in various traits, and constitute probably a step backward towards the archetypes from which the *spontaneum* clones have emerged. Further selfing, if the selected seedlings arrow in 1956 and are bisexual, should throw some light on this question unless, of course, the subsequent populations attain homozygosity.

The seedling populations studied this year, especially those of the two first glagahs, displayed considerable variation in many characters, such as diameter and length of stalk, leaf width and number of tillers (see fig. 6). Some of the extreme values found in Glagah Kloet are as hereunder.

	Number of tillers	*Stalk*		*Leaf width*
		Diameter (mms.)	Length (cms.)	(cms.)
Extremes	12-60	0.5-1.3	2.5-20.0	0.6-4.0

Several Glagah Kloet seedlings had thicker stalks and wider leaves than those of their parents, thus showing the impurity of the *spontaneum* stocks. Stalk diameter and leaf width showed a pronounced positive correlation. Some of the seedlings derived from all three glagahs had surprisingly short stems and narrow leaves.

The seed bearing fuzz was of extremely low fertility at Réduit in 1955, producing the unprecedented low number of a little over two seedlings per cross, as compared with 53 in 1954 and 293 in 1953. At Pamplemousses, the fuzz was much more fertile, and supplied practically the total number of seedlings transplanted to the field at the four Experimental Stations, the number of seedlings per cross being 300, as against 342 in 1954 and 320 in 1955. These averages, however, may not give quite a correct picture of the decrease in fuzz fertility at Réduit and of its maintenance at a high level at Pamplemousses, the type of crosses made varying with different years.

Fig. 6. Selfs of *Saccharum Spontaneum*, Glagah Kloet clone, showing variation in leaf width.

The low fuzz fertility at Réduit, which had been actually predicted before hybridization was in full swing, is ascribed to the low percentage of open anthers in the male parent varieties, to bad pollen quality, and possibly also to low fertility of the pistillate parents. This hypothesis is partly based on the surveys made in 1954 and in 1955 to assess the effect of climatic conditions on anther opening in the varieties M.63/39 and Ebène 1/37, the results of which are discussed in a separate section of this report.

There is ground to believe that environmental conditions have, on the whole, been more and more unfavourable to pollen quality since 1953, the year 1955 being, in all probability, the worst on record for seedling production since the inception of the Sugarcane Research Station in 1930.

It is difficult to explain the uniformly good results obtained at Pamplemousses during the 1953—55 period. Not only did the survey show a considerable reduction in the percentage of dehisced anthers in M. 63/39, but arrows of proven male parent varieties, collected throughout the crossing season, for routine examination in the laboratory, gave, in general, little pollen, the same phenomenon being observed at Réduit. It would, therefore, be necessary to suppose that, at Pamplemousses at any rate, pollen has been produced in adequate quantity, despite the comparatively low percentage of open red or purple anthers.

Perusal of the Annual Reports of the Sugar-cane Research Station for the period 1942-52 brings forward the interesting point that, although no accurate figures can be quoted for percentage of arrowing due to lack of data, years of intense flowering appear to be characterised by high fuzz fertility.

Although the unfavourable conditions, at Réduit particularly, may revert to normal in the future, it has been decided to plant a breeding plot, including the commonly used male parent varieties, at the Experimental Station of the Department of Agriculture, Richelieu, where pollen of good quality is produced in large quantities owing probably to high temperature and low air humidity.

At Réduit, fuzz was sown in seed boxes (14″ x $8\frac{1}{2}$″ x 2″) containing John Innes seed compost prepared at Barkly Experimental Station of the Department of Agriculture through the courtesy of Mr. H. Julien. Imported hoof and horn was added to the compost. Fuzz from crosses made at Réduit produced very few seedlings. Fuzz from the cross B. 34104 x M. 63/39, made at Pamplemousses, yielded a large number of seedlings which were pricked at the right stage in some 40 flats. Growth of the pricked seedlings was irregular due to lack of homogeneity of the compost.

At Pamplemousses, fuzz was sown in the standard soil-manure mixture with very satisfactory results. Fuzz from a few Réduit crosses was sown at Pamplemousses but failed to germinate, thus indicating no fault in the sowing technique at Réduit.

No case of damping-off was noticed in 1955, and even potted seedlings from dense flat populations grew remarkably well.

Transplanting began mid November at Réduit and Pamplemousses, i.e. a fortnight earlier than usual, and beginning of December at Belle Rive and Union Park.

Bunch planting of seedlings was made on a small scale at all four stations for experimental purposes.

A summary of the breeding work carried out in 1955 is shown in Table 1, while the list of crosses made is given in Table XVI of the Appendix.

Table 1. Summary of breeding work in 1955.

Experimental Stations	Number of crosses made	Number of seedlings obtained	Number of seedlings transplanted
Réduit	81	186	[illegible]
Pamplemousses	100	30,280	8,543
Belle Rive	—	—	5,810
Union Park	—	—	2,720
Total	181	30,466	27,44[illegible]

2. SELECTION

In conformity with the research policy of the Institute to produce early maturing varieties, and in the light of results of previous research on seedling selection in ratoon, all plant cane seedlings have been cut and allowed to ratoon for selection in August 1956.

The seedlings at Hermitage Experimental Station were selected in ratoon, and 156 seedlings, equivalent to 1.5% of the populations, retained for planting in a propagation plot at Belle Rive. The propagation plot consists of single lines 10 ft. long of each selection, a row of the control variety occurring after every five seedlings. The plot will provide enough cuttings for laying down second trials (now re-styled *First Selection Trials*) with three blocks 15 feet long instead of two blocks as in the old system of layout.

First selection trials constitute an important stage in seedling testing and allow of good ratooners being sorted out early ; a sound design, consistent with the limited amount of planting material available is, therefore, of great importance. Three repetitions instead of two will no doubt decrease the error variance of the trials and make selection more trustworthy.

The inclusion of a multiplication plot, with replicated rows of a control variety, as an intermediate step between the original seedling populations and the first selection trials, allows of the quick elimination of poor seedlings which lose vigour when planted from cuttings. First selection trials will, due to their containing less seedlings, be of smaller size than the ordinary second trials although there will be three randomized blocks. If the new design proves successful, it will become a routine practice for testing selected seedlings. The advantage of having ample seed material for laying down the first selection trials must also be emphasized.

Seedlings in one field at Réduit have been selected but not planted, and will be re-selected in ratoon in 1956. Data of their performance in plant cane and ratoon will allow of correlation co-efficients being worked out between stool weight and Brix. This work is a sequel to research already carried out on selection in ratoon versus selection in plant cane, which showed that seedling selection from first ratoon populations is preferable to selection in plant cane.

Selection from first selection trials was made in August, and 46 varieties planted in multiplication plots for inclusion in pre-release trials on estates in 1956. As usual, Brix, yield of cane, percentage of arrows, have been determined. It is interesting to note that the mean Brix of M. 134/32, the control variety, was 22.4 in the plant cane trials planted at Réduit on the 1st of September, as compared with 21.6 in those laid down on the 1st of December the same year, despite the fact that the Brix of the latter trials was taken 15 days later and that maturation conditions were exceedingly good. This points to the necessity of planting trials at the proper season.

3. PRE-RELEASE VARIETY TRIALS

The general policy has been up to now to establish a larger number of trials in the humid zone of the island as it comprises 65% of the cane area. The distribution of these trials up to 1955 is shown in table 2.

Table 2. Distribution of pre-release variety trials

	Climatic Zones				Total
	Sub-humid	Humid	Super-humid	Irrigated	
No. of trials	4	26	11	6	47

Greater bias might have to be given in the future to the testing of varieties in the drier localities, which cover an approximate area of 27,000 arpents, as the varieties now being cultivated appear to be at their best in areas where annual precipitations exceed 50 inches.

Trials planted in 1955 comprise varieties of the M./46 to M./50 series, the white and striped sports of M. 134/32, A. 1 and A. 2 (two varieties bred from wind-pollinated arrows at Astroea S. E.), Ebène 1/44, M. 311/41 (under irrigation conditions) and the imported varieties R. 366, R. 397, Trojan and Pindar. The controls are M. 134/32, Ebène 1/37 and B. 3337. Twenty-two trials have been harvested in 1955. In order to assess their maturity behaviour, the varieties M. 311/41, M. 129/43, M. 147/44, M. 31/45 and the white and striped sports of M. 134/32, were reaped at three periods during the harvesting season: early (July—August), middle (September—October) and late (November—December). Random ten — stalk samples have been analysed from each plot so that four sets of figures are available for each variety per trial. The average C.C.S. values at different dates for M. 129/43, M. 147/44 and M. 31/45, in comparison with M. 134/32, are given in table 3.

Table 3. Variation in C. C. S. of three varieties compared to M. 134/32.

Variety	July — August		September — October		November — December	
	No. of harvests	C. C. S.	No. of harvests	C. C. S.	No. of harvests	C. C. S.
M. 129/43	16	+ 0.9	18	— 0.7	9	— 0.8
M. 147/44	13	+ 0.9	21	+ 0.1	10	— 0.8
M. 31/45	25	— 0.2	39	+ 0.2	16	— 0.4

The above figures, give some indication that both M. 129/43 and M.147/44 appear to have high early sugar, while M. 31/45 is probably medium to late maturing. The average C.C.S. for M. 147/44 is about one unit higher than for M. 134/32, but the figure may decrease when more data in ratoons become available.

The productive figures of M. 129/43, M. 147/44 and M. 31/45 in plant cane and ratoon are summarised in Table 4 and allow of the following conclusions being drawn:

(a) M. 129/43 is on a par with M. 134/32 in yields of cane and sugar. It seems to have better juice than M. 134/32 at the beginning of the grinding season, but more data of its field behaviour are necessary before its release for commercial growing can be considered. Germination is poor, particularly under high rainfall conditions. The cane is liable to lodge unless cut early in the season.

(b) M.147/44 has given outstanding results in plant cane and ratoons. Its high early sucrose content is a valuable asset. Its stalks are of medium size, and its leaves thin but numerous (some 20 per cane). Its tendency to produce side shoots, especially in the drier and irrigated localities, is a weak point which, however, does not offset its good traits. This defect is genetic and appears in some of its progeny. It is as yet impossible to say whether M. 147/44 is more adapted to the humid and superhumid zones than to dry localities ; it responds well to irrigation in the Western sector. Its susceptibility to chlorotic streak appears to be about the same as that of Ebène 1/37.

(c) M.31/45 has proved superior to M.134/32 in yield of cane by quite a considerable margin, and its juice is, on the average, as good as that of M. 134/32, but inferior to that of Ebène 1/37. It is probably medium to late maturing. It has thick stalks and a high tillering power. It performs better than M. 134/32 and Ebène 1/37 in soils which are priodically water-logged. It appears less susceptible to chlorotic streak than Ebène 1/37.

Yield figures for the variety M.311/41, which has only given promising results under irrigation, are as yet too fragmentary for consideration in this report.

The pedigree of Mauritius seedlings is shown in fig. 5.

Of the varieties imported in 1950, namely, M. 336, P. R. 905, M. L. 3—18, Co. 419 and Co.421, none appear worthy of further trial on estates. Co.419 and Co.421 are very susceptible to ratoon stunting disease ; the former showed spectacular reductions in yield in ratoon in a trial on the high plateau, while the latter is very severely stunted in plant cane. Both varieties are being used for breeding purposes.

M. 336 and M. L. 3—18 have good juice, but have been largely surpassed by M. 134/32 in yield of cane and sugar, particularly the former variety. They might prove useful parental types to produce early maturers.

The productive figures of P. R. 905 fall short of those of M. 134/32 by a narrow margin, but it appears unlikely that this variety will be capable of competing successfully with the cultivated standard varieties. P. R 905, derived from S.C. 12/4, has been extensively used in experimental crosses for the past three years.

The white and striped sports of M. 134/32 have given as good results in plant cane as

Table 4. Summarised 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. p. a.		Sig. Diff.	Climatic zones
		129/43	134/32		129/43	134/32	129/43	134/32	129/43	134/32		
Plant cane	8	36.20	37.47	3.67	86 0	83.8	12.5	11.8	4.58	4.45	0.45	Humid and irrigated
Ratoons	8	31.46	29.90	2.04	88.5	88.4	13.3	13.7	4.21	4.09	0.27	
Average	16	33.83	33.68	2.22	87.2	86.1	12.9	12.6	4.39	4.27	0.28	
		147/44	134/32		147/44	134/32	147/44	134/32	147/44	134/32		
Plant cane	9	48 20	38.18	5.96	89.0	86.9	13.7	12.7	6.61	4.88	0.79	Humid, super-humid, & irrigated
Ratoons	6	39.33	31.95	3.09	86.9	86.6	13.3	13.0	5.24	4.17	0 40	
Average	15	44.60	35.70	3.38	88.2	86 8	13.5	12.8	6.06	4.59	0.44	
		31/45	134/32		31/45	134/32	31/45	134/32	31/45	134/32		
Plant cane	13	45.29	34.21	5.02	84.8	84.3	11.9	11.5	5.40	3.96	0.60	Sub-humid, humid, super-humid and irrigated
Ratoons	24	35.23	28.52	1.64	87.1	86.9	12.6	12.7	4.46	3.64	0.21	
Average	37	38.76	30.52	0.64	86 3	86.0	12.3	12.3	4.79	3.75	0.08	
		31/45	E.1/37		31/45	E.1/37	31/45	E.1/37	31/45	E.1/37		
Plant cane	5	35.58	29.20	7.02	84.5	85.7	11.5	12.1	4.11	3.55	0.82	Super-humid
Ratoons	12	36.00	33 01	1.55	87.9	89.1	12.4	13 6	4.48	4 51	0.20	
Average	17	35.88	31.89	1.95	86.9	88.0	12.1	13.2	4.37	4.22	0.25	

the standard red variety in three trials under humid, superhumid and irrigated conditions. Both varieties have already been grown for several years mostly in the Black River district, where the white sport is as good as M.134/32. The striped sport is unstable and mutates back to the white type of cane, so that it is, at times, difficult to obtain an adequate supply of cuttings for trials.

As stated elsewhere in this report, the Cane Release Committee recommended that M.147/44, M.31/45 and B.34104 should be added to the list of approved varieties for commercial planting.

Correlation between yield of M.134/32 in variety trials and estate fields.

The opinion has often been put forward locally that cane yields in pre-release trials are exaggerated and generally above those obtained on estates.

A survey of the yield of M.134/32 in pre-release variety trials and in estates' fields was carried out during the year. The yield of 54 fields, in which trials had been laid down, was compared with that of M.134/32 in the trials themselves, in plant cane and ratoons.

The data obtained, although not showing a one-to-one correspondence between the two sets of yield figures, do indicate good parallelism between trial and field yields. The mean yields were 33.0 and 33.8 tons of cane per arpent, respectively. In a certain number of cases, the yield of estate fields surpassed considerably that of the control variety in trials. The differences in plant cane are not more pronounced than in ratoons. There is, therefore, good reason to assume that cane yields in variety trials are, on the whole, comparable to those of estate fields.

4. IMPORT AND EXPORT OF CANE VARIETIES

Of the varieties imported in 1954, Q. 44, Q. 47, Q. 57, 28 M. Q. 1370, U. S. 48—34 Co. 779, Pepe Cuca, P. R. 1000, B. 4362, H. 37—1933, 27 M. Q. 1124 and N. Co. 310, will be released from quarantine and multiplied at Réduit in May 1956. A second generation of E. P. C. 39—393 will be established in the glasshouse in January.

The variety Co. 911 was destroyed because of the presence of leaf symptoms suggestive of mosaic.

P. O. J. 3016 and B. 4362, introduced in 1952, are being multiplied at Réduit and will be planted in pre-release trials in 1956.

Steps have already been taken to import 21 new varieties in 1956, mostly for breeding purposes.

Cuttings of the following varieties have been exported during the year:

South Africa: D. 109, D. K. 74, M. 72/31, M. 147/44, M. 31/45, B. 41227, R. 366, R. 397.

Australia : M. 311/41, M. 129/43, M. 147/44, M. 31/45, Fotiogo, Mapou Perlée.

Iran : M. 112/34, Ebène 1/37, B. 37161, B. 37172.

5. INDUCTION OF ARROWING.

(a) Experiments have been 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. Canes of these varieties were marcotted in January and February and, after adequate root production, cut and planted vertically in four-gallon petrol tins. The tins were tilted in a horizontal position in groups of five, at weekly intervals, as from the beginning of March. Canes kept in the original vertical position were used as control. Curvature of the experimental canes took place in about fifteen days. Lateral buds developed on most of the canes after a while and had to be cut off regularly in case they interfered with protrusion of any induced arrows.

The canes were kept until the end of August, but none responded to the treatment. As already mentioned in the Annual Report of the Sugar cane Research Station for 1949, it is possible that a time factor might come into play, and that only canes laid down horizontally at a definite period, i.e. after hormone production, will flower. The experiment will be therefore repeated next year to cover a longer period.

(b) Leaves of B. H. 10/12 and Black Tanna canes at Réduit were sprayed at the end of March with aqueous solutions containing minute quantities of minor elements. Alternate lines of canes were kept as control, care being taken to prevent wind drift. The experiment has given negative results, and will not be repeated prior to determining leaf composition of arrowing, arrowed and non-arrowed canes by spectrographic analysis.

(c) Small plots of R. P. 8. and B. H. 10/12 planted in different localities of the island, where B. H. 10/12 is known to have arrowed sporadically in the past, have failed to tassel. It must however be again remarked that the year under review has not been conducive to arrowing.

6. RATOONING CAPACITY OF NEW VARIETIES

The latin squares laid down at Pamplemousses, Belle Rive and Union Park have been harvested in plant cane and ratoons. The trial at Réduit germinated very badly and had to be recruited twice, so that yield data have not as yet been obtained.

All cuttings were hot air treated except those planted in the first latin square at Pamplemousses. Sterilised knives have been used at harvest.

The results obtained are appended in Table 5, the yield figures being the combined weight of shoot and leaves.

Table 5. Ratooning capacity of new varieties.

Category	Age (mths)	Mean Yield (Kgs.)				
		M. 171/30	M. 134/32	M. 129/43	M. 147/44	M. 31/45
Pamplemousses — Untreated cuttings — Irrigated						
Plant cane	6½	—	50.2	50.8	82.3	80.5
First ratoon	3	—	56.2	59.2	71.5	79.7
Second ratoon	4	—	29.2	34.5	45.2	41.5
Third ratoon	4	—	15.5	16.2	29.5	25.5
Pamplemousses — Treated cuttings — Irrigated						
Plant cane	2	28.6	43.0	47.4	48.8	53.2
First ratoon	4	37.0	36.8	48.2	49.0	60.0
Second ratoon	5	8.4	13.2	18.0	22.2	18.6
Belle Rive — Treated cuttings — Not irrigated						
Plant cane	6	38.8	36.2	35.8	56.8	62.8
First ratoon	7	8.2	5.0	5.4	18.2	14.8
Union Park — Tre ted cuttings — Not irrigated						
Plant cane	7½	43.6	10.2	21.0	40.2	63.8
First ratoon	6	22.6	20.2	15.2	49.0	35.6

It may tentatively be concluded from the above figures that M.129/43 ratoons as well as M.134/32, while M.147/44 and M.31/45 have a high ratooning capacity which markedly exceeds that of the control under irrigation and in the superhumid localities. It must be mentioned that these results are in agreement with those obtained in pre-release trials given in table 4. The ratoons can be more frequently cut at Pamplemousses because of better growth conditions. The low figures for M.134/32 and M.129/43 in plant cane at Union Park are due to heavy recruiting; the first ratoon results appear more reasonable. The results of the two latin squares at Pamplemousses cannot be compared due to different planting and harvesting dates.

Cutting the canes at short time intervals stimulates tiller formation, and results in an abnormally high number of shoots per stool, particularly in M.147/44 and M.31/45. It is intended to continue the trials in old ratoons to assess the effects of such traumatic treatment on ratooning.

7. EFFECT OF ENVIRONMENT ON ANTHER FERTILITY

Studies on the effect of environment on anther fertility were continued during the year using the varieties M. 63/39 and Ebène 1/37. Arrows were collected from June to September and the percentage of open anthers was determined from random samples of 500 anthers derived from 5 to 6 arrows collected in different parts of a field.

There was, as in 1954, a high correlation between percentage of open anthers and altitude in both varieties. Open anthers decreased from sea level to the high plateau, the total percentage attaining zero value at about 700 ft. altitude in M. 63/39, as against 1,000 ft. in 1954, and at 1,000 – 1,200 ft. in Ebène 1/37.

M. 63/39 and Ebène 1/37 are not the only varieties showing this curious relationship. Thus P.O.J. 2878, B. 34104 and Co. 419 display variation in male fertility with height above the sea, but probably to a lesser degree than M. 63/39. For instance, arrows of Co. 419 collected in different localities on the same day showed the following percentage of dehisced anthers:

Pamplemousses	200 ft.	77%
Réduit	1,040 "	11%
Hermitage	1,400 "	6%

Anthers of M. 63/39 collected in Réunion Island by Mr. D. d'Emmerez de Charmoy were despatched by air in sealed envelopes to Mauritius. Counts made locally showed that, as in Mauritius, anther opening varies inversely with altitude. There was no correlation at all with the total annual rainfall. M. 63/39 does not arrow above 1,200 ft. in Réunion, and at 1,000 ft. little anther dehiscence takes place.

Anther examination throughout Mauritius revealed the important fact that, while the percentage of open anthers in M. 63/39 was 43% for the whole island in 1954, it was only 27% in 1955, the percentage also attaining higher individual values in the low lying districts in 1954.

As counts of open anthers in M. 63/39 and Ebène 1/37 made at weekly intervals showed no definite trend with time, fertility contour maps have been drawn with the data obtained in 1955. The Western Sector (Black River district), with its low rainfall and high temperatures, seems ideal for pollen production; the contour lines are closer in this district than in the other districts. As a result of this observation, it was decided to establish a breeding plot of male varieties at the Experimental Station of the Department of Agriculture, Richelieu, in the Black River district.

8. RELATIONSHIP BETWEEN DENSITY BRIX, REFRACTOMETER BRIX AND C.C.S.

A problem of some importance which the cane breeder often has to confront is the choice between two variables in order to predict a third variable.

For example, it is interesting to determine whether C.C.S. % cane can better be predicted, on the average, from the density Brix or the refractometric Brix.

The refractometric Brix of some 378 samples of different varieties analysed for C.C.S. was taken with a hand Zeiss refractometer, and the density Brix of the extracted juice from the shredded canes was determined. The data from 100 random samples have been subjected to statistical anaylsis with the following results.

There is a close relationship between all three variables as revealed by dot diagrams and correlation coefficients. It has been definitely established in many countries that these functions are linearly related, so that the scatter of individual Brix and C.C.S. values on dot diagrams must be attributed more to sampling and analytical errors (particularly errors due to fibre determination) than to actual variation in the values themselves.

The correlation coefficients found are:

Between refractometric Brix and C.C.S.	+ 0.656
" density Brix and C.C.S.	+ 0.726
" refractometric Brix and density Brix	+ 0.765

These coefficients are highly significant, and of the same order of magnitude as those found by other workers.

Using Hotelling's test, which is based on a first order determinant, the calculated t value was found to be 1.47, as against the theoretical value of 1.97 at the 5% level. Thus there appears to be no significant difference between the density Brix and refractometric Brix for forecasting the C.C.S.

Fig. 7. New Chemistry and Sugar Technology laboratories at Réduit. Cane analysis laboratory in back ground.

NUTRITION AND SOILS

1. THE COMPOSITION OF CANE JUICE

D. H. PARISH

THE AMINO-ACID AND NITROGEN CONTENTS OF CANE JUICE

THE amount of nitrogen present in sugar cane is extremely small and belies the importance of that element to the life of the plant and also to the manufacture of sugar from it, as Wiggins (1), in his review of the present state of knowledge of the nitrogenous compounds in sugar cane, states.

Whilst amino-acids for a long time have been suspected of exercising some important influence on the limitation of crystallization of sucrose from molasses, there have been no specific developments of the subject in this direction, since emphasis has been placed on the effects of reducing sugars and inorganic salts. Recently, however, Kelly (2) has advanced a new concept purporting to explain the limitation of the crystallization of sucrose from molasses. This explanation which to quote the author, " is based on the results of fundamental phase equilibria investigations of multi-component sugar systems ", is founded on the concept that when an organic solute other than sugar reaches saturation in concentrated molasses then the crystallization of sucrose ceases. Amino-acids because of their very low solubilities, despite their small concentration, may thus exercise a controlling influence on sucrose crystallization.

Wiggins and Williams (3) have drawn attention to the possible effects of amino-acids on sugar manufacture by pointing out that their presence to a greater or lesser extent in cane juice will alter the amount of lime necessary for the successful defecation of cane juice; the amount and type of amino-acid present in the juice will affect the colour of

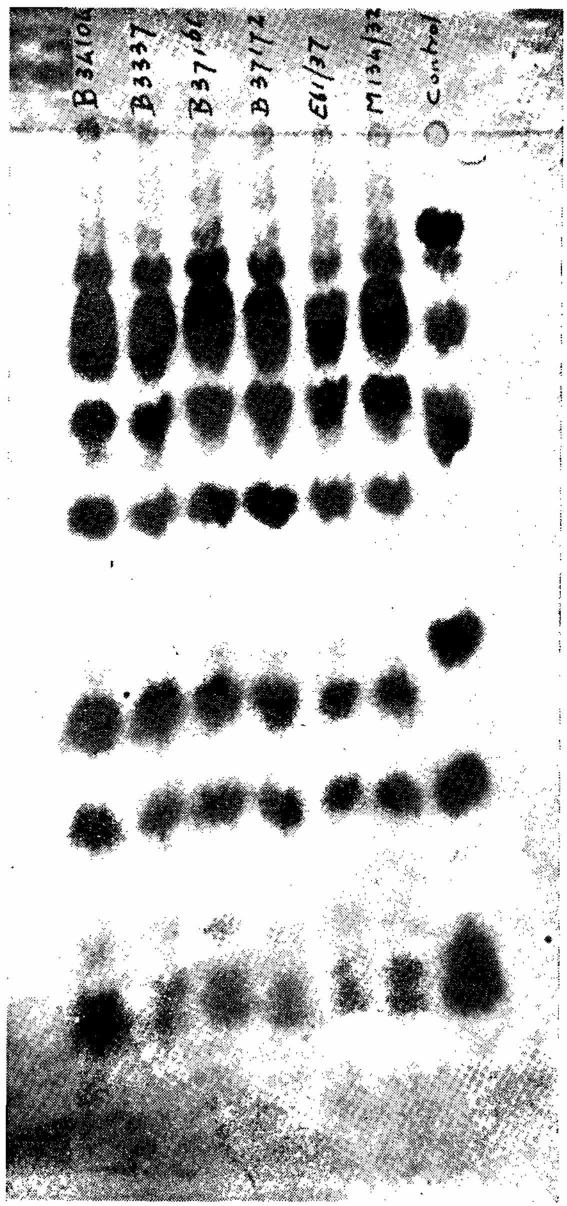


Fig. 8. Chromatogram of amino-acids present in the juice of six varieties. Amino-acids present in control mixture are in descending order : lysine asparagine, aspartic acid, glutamic acid, alanine, amino-butyric acid, valine, iso-leucine and leucine.

the syrup ultimately produced and because amino-acids and reducing sugars react together to form polymeric and colloidal materials they will also have an effect on the yield of sugar ultimately obtained.

In addition to the importance of amino-acids and other nitrogenous materials of juice to the technological aspects of sugar production they are important biochemically as little is known of their qualitative and quantitative distribution and the changes which occur as a result of such factors as maturation, drought and fertilization.

EXPERIMENTAL

Material and sampling. The samples of juices used in the work were obtained from the post-release trials planted in June 1954. The trials consist of six varieties namely:

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

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

N1. Low level nitrogen fertilization 20 kgs. N/arpent
N2. Medium " " " 40 " "
N3. High " " " 60 " "

There are three dates of harvest of the cane: the middle of July being the early harvest period, the middle of September the mid-season harvest period and the middle of November the late harvest period.

These experiments have been laid down in 3 places of low rainfall, i.e. with an annual rainfall of about 60″ and three places of higher rainfall, i.e. with an annual rainfall of 90″—130″. All the plots were of satisfactory P & K status as determined by foliar diagnosis.

The samples from each plot consisted of 30 canes. These canes were laid out roughly in order of increasing size, and chopped into three approximately equal lengths. Sub-samples of 10 bottom, 10 middle and 10 top portions were taken, giving a sample of 10 composite canes. The sub-sample was shredded in a "Cutex" type shredder. The juice was extracted from a portion of the shredded mass by pressing at 100 Kg/cm^2 pressure in a hydraulic press, and then filtered through cotton wool. The sampling and shredding procedure is the one normally used in this Institute.

ANALYTICAL PROCEDURES

Amino-acids (total) were determined by the Wiggins & Williams (4) modification of the ninhydrin method of Moore & Stein (5). The method, with slight modifications, is given here in full, because, once a reference curve has been obtained, it is extremely simple to carry out and, as eighteen samples can be analysed in about 2 hours, is a fairly rapid method.

Determination of total amino-acids in sugar cane juice

Reagents

Ninhydrin. Ninhydrin 1.0 gram dissolved in 100 ml. of isopropyl alcohol. The solution should be stored in a brown stoppered bottle away from sunlight and should not be kept for more than one month.

Acetate Buffer. Sodium hydroxide 40 grams and glacial acetic acid 100 ml. dissolved separately in water were mixed and diluted to one litre.

Aqueous Isopropyl Alcohol. Equal volumes of isopropyl alcohol and distilled water.

Clarifying mixture Bentonite clay 15 grams, heavy kaolin 20 grams and acid-washed activated charcoal 50 grams suspended in 1 litre of water.

Procedure

The solution for analysis was prepared by mixing 20 ml. of juice with 5 ml. of clarifying solution and diluting to 200 ml. in a graduated flask. Filtration through Whatman No. 1 filter paper gives a colourless filtrate representing a tenfold diluted juice. Occasionally some haziness is encountered in the filtered solutions but refiltering usually removes this.

The filtrate 5 ml., ninhydrin solution 2.5 ml., acetate buffer 2.5 ml. and 5 ml. of distilled water were pipetted into a 2.5 x 20 cm. test tube and mixed thoroughly. The test tubes were marked at 25 ml. and 50 ml. with a file, as depending on the depth of the final colour the contents were diluted to the 25 or 50 ml. mark.

A globe-condenser was put into each tube and groups of six test tubes were placed in tight fitting wire-netting baskets which were weighted and placed in a vigorously boiling water bath. It is essential to ensure that the bath is boiling briskly and that the liquid contents of the test-tubes are submerged, as otherwise low results may be obtained.

The globe-condensers are necessary in that they prevent excessive evaporation from the test tubes; small funnels may be used as an alternative.

After 30 minutes the tubes are removed, cooled in running water and the contents made up to the mark. The absorbance of the solution was measured in a Lumetron colorimeter using the yellow filter 580.

The concentration of amino-acids in the solution for analysis was read directly from the curve (fig. 9) constructed by using standard amino-acid solutions in the above procedure. The concentration in the original juice is calculated using the appropriate dilution factor.

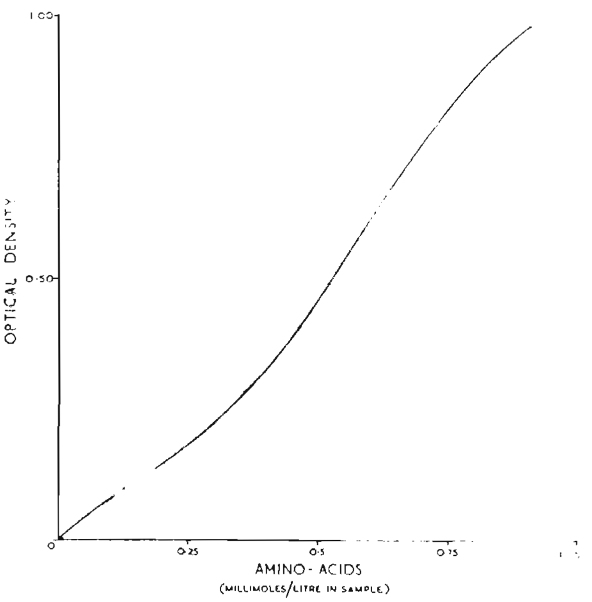


Fig. 9. Reference curve for determination of amino-acids with ninhydrin in the presence of acetate buffer. Each point represents the mean value of 3 determinations made with standard solutions of glutamic acid, asparagine and alanine.

Chromatography

For chromatography the amino-acids were isolated by absorption on Amberlite I R 120 (H) cation exchange resin; 10 ml. of juice diluted to 25 ml. with water being added to 2 grams. of the wet resin in a beaker. After shaking for a short while the sample was left in contact with the resin overnight. The supernatant liquid was decanted off and the resin was washed three times with small quantities of distilled water. 10 ml. of 2N ammonia solution were added to the resin, the resulting mixture of ammonia and amino-acids being applied directly to chromatogram paper Whatman No. 1.

The solvent used was that recommended by Buzatti-Traverso (6), i.e. 4 parts n-butanol, 1 part acetic acid, 5 parts distilled water; but instead of using it when freshly made the two layers of the mixture were kept together for several days to stabilize. The spray reagent was that described by Williams and Wiggins (7).

RESULTS

Fig. 8 is a photograph of a typical chromatogram showing the distribution of the amino-acids from the six varieties. On the left is a control mixture of the amino-acids lysine, asparagine, aspartic acid, glutamic acid, alanine, amino-butyric acid, valine, isoleucine and leucine.

Fig. (9) is the reference curve for the determination of amino-acids with ninhydrin in the presence of acetate buffer.

The colour reaction of amino-acids with ninhydrin has the disadvantage that different amino-acids give different amounts of colour; added to this limitation is the fact that the reference curve in the Wiggins modification is not a straight line. It would seem however that in view of the great variability in the concentrations of total amino-acids encountered the method is useful as a guide.

The results of the nitrogen analyses in graphical form are given in fig. 10. The levels of nitrogen content used are the mean figures for varieties and places i. e. the mean of 36 results. Fig. 11 gives the mean contents of total amino-acids.

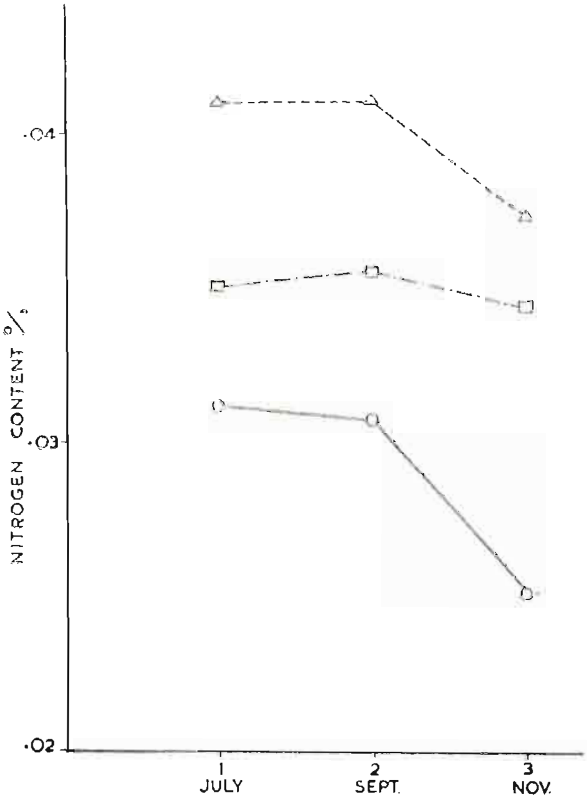


Fig. 10. Effect of nitrogen fertilization and maturity on the nitrogen content of juice. Circles indicate the N1, squares the N2, and triangles the N3 levels of fertilization.

The histograms (figs. 12 and 13) show the minimum, maximum and mean levels of nitrogen and total amino-acids for each of the six varieties.

Fig. 14 has been obtained by taking the lowest and the highest levels of amino-acids occurring (mean of six varieties) for each level of nitrogen.

Fig. 15 gives the C.C.S. per cent. cane for the three levels of nitrogen and the three harvest periods and as in figs. 10 and 11 are the mean values of varieties and places.

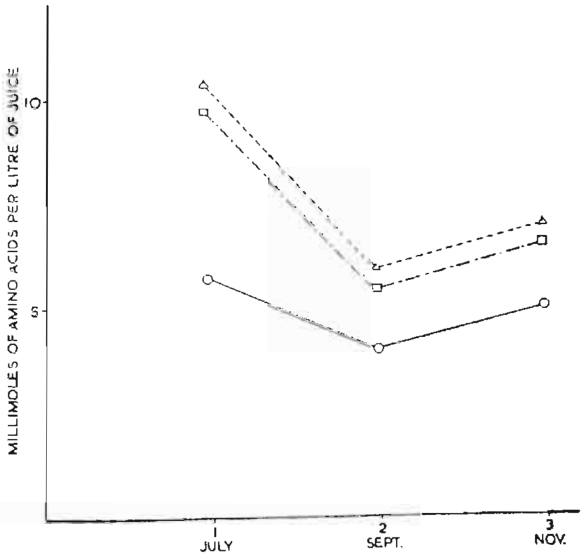


Fig. 11. Effect of nitrogen fertilization and maturity on the total amino-acid content of juice. Circles indicate the N1, squares the N2, and triangles the N3 levels of fertilization.

DISCUSSION

Wiggins (1) in his review of the nitrogen containing non-sugars present in cane put forward the opinion that because of the small amounts of these materials present in juice, research workers have been deterred from studying their nature and distribution ; for it is a fact that only the most meagre amount of information has been published on this subject. Of some fifty references given by Wiggins, twenty are to work more than thirty years old. It is obvious then, that a further limitation of the value of the small amount of published work on these nitrogenous constituents of cane juice is that of age. Some of the chemical methods used in identifying certain constituents are now known to be faulty and added to these limitations are the considerable changes which have taken place in the varietal picture and in management practices all of which have probably influenced the composition of the cane. With the advent of paper partition chromatography a particularly simple and elegant method was made available for the separation of the simpler constituents of plant material. Chromatographic examination of cane uice has been carried out by Wiggins (1, 3 & 4) by Kowkabany, Brinkley and Wolfram (8). Cane molasses have been examined by Kelly and Thompson (9) and a study of beet molasses has been made by Mariani and Torraca (10).

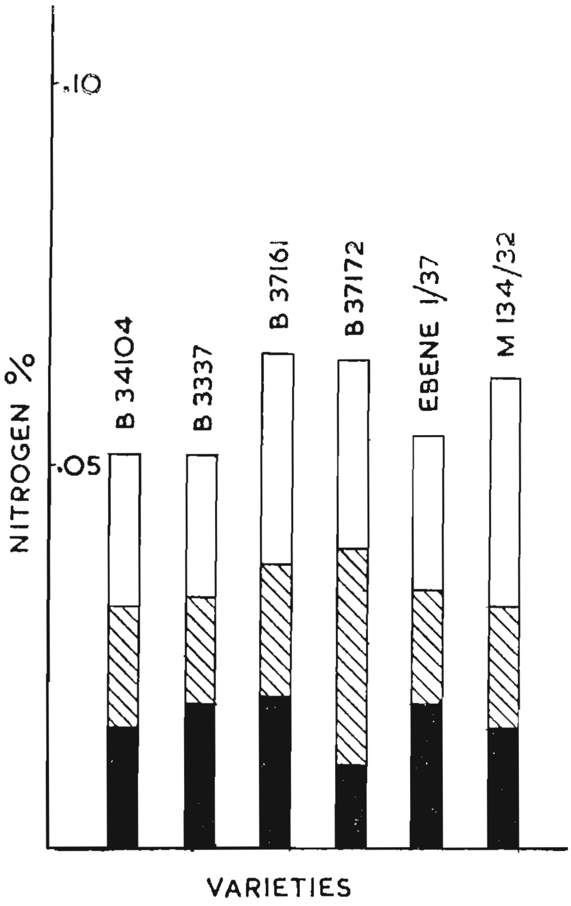


Fig. 12. Maximum, mean and minimum levels of nitrogen occuring in juice of the six varieties.

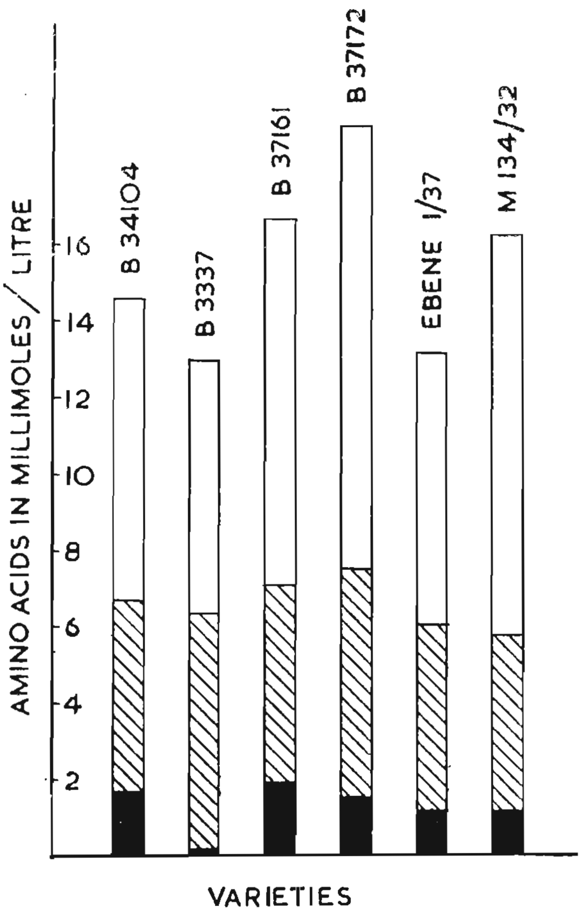


Fig. 13. Maximum, mean and minimum levels of total amino-acids occuring in the juice of the six varieties.

Of the ninhydrin reacting compounds present in cane juice Wiggins et al. have described the separation of aspartic, glutamic and amino-butyric acids, glycine, alanine, asparagine, glutamine, lysine, serine, leucine and valine. Glutamine is probably converted into glutamic acid during the ion-exchange treatment since although Pratt & Wiggins (11) demonstrated its presence in raw cane juice, it is not detected in the juice treated by ion-exchange.

In all, twenty amino-acids (for the most part having L configuration at α C) are generally found as protein components throughout the whole range of living organisms. These twenty have likewise all been found free in plant material although concentrations may in particular cases be so low as to give negative results by ordinary means of detection.

The chromatogram shown in fig. 8 shows very clearly the important fact that as far as the major amino-acid constituents of juice are concerned varietal differences are small; this fact has also been observed by Wiggins et al (4).

Previous work carried out on the nitrogen contents of juice [Prinsen Geerligs (12)] indicated that the nitrogen content of juice may vary between 0.018% and 0.062%. The histogram (fig. 12) showing the lowest, highest and mean levels of nitrogen for the six varieties under the varying conditions of the experiment, gives a range of 0.011—0.065% which is rather wider than the range given by the above author.

The histogram of the amino-acid contents gives a range of 0.05—19.2 millimoles of amino-acid/litre. The mean values for all varieties are around 6.5 millimoles per litre.

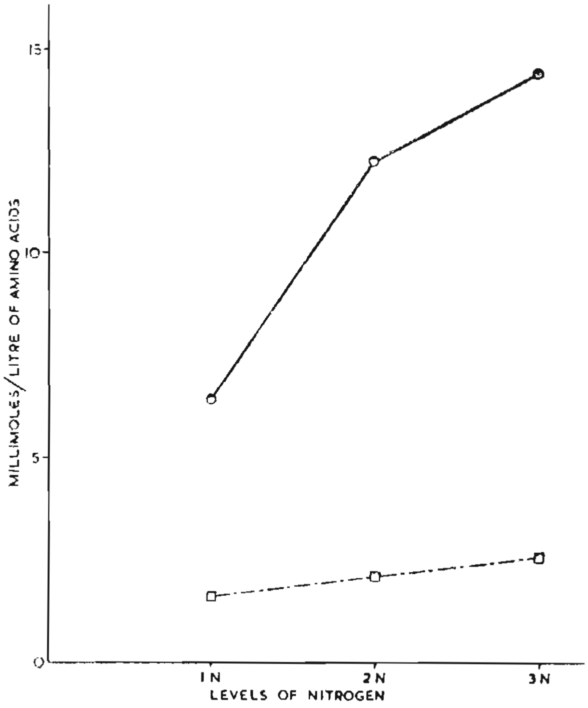


Fig. 14. Influence of nitrogen fertilization, rainfall, and time of harvest on the total amino-acid content of juice. The points are the mininum mean and the maximum mean of the six varieties at each level of nitrogen.

Plain line points were from the early harvest period and from a dry district. Broken line points were from the late harvest period and from a wetter district.

The effect of nitrogenous fertilization and time of harvest on the nitrogen contents of plants have been widely examined and some general conclusions can be drawn. With increasing age i.e. with a movement from the vegetative state to the reproductive state there is a great increase in carbohydrate material, the nitrogen content consequently falling. The effects of nitrogenous fertilizers on the composition of plants are two-fold; firstly there is an increase in the nitrogen content of the plant and, as there is no effect of nitrogen on the insoluble structural carbohydrates there is consequently a fall in the soluble carbohydrate material ; secondly, nitrogen application increases the water content of the plant, thus depressing the actual level of all constituents. According to Pearsall & Ewing (13) high N intake causes a rise in pH of the cell sap and this permits a greater swelling of the protoplasmic colloids. To this feature, the higher water content and reduced transpiration of plants receiving high-N manuring are ascribed. Fig. 10 giving the influence of stage of harvest and level of nitrogenous fertilization shows these typical effects well ; with increase in nitrogenous fertilization, in all cases, there is an increase in the nitrogen content of the juice, the effect of maturity being to cause a fall in the nitrogen content

Fig. 11, giving the amino-acid levels, follows the trend for nitrogen content as regards nitrogenous fertilization but although there is a fall in amino-acid content from the first to the second cutting there is a rise from the second to the third harvest. This would seem to be explained by taking the results of the work of Wiggins et al (4) in which it is shown that drought causes an increase in the level of total amino-acids in juice The period between the second and third harvests was characterized by exceptionally dry conditions irrespective of the site of the experiments.

Fig. 15 gives the C.C.S. per cent cane (mean of six varieties) and corroborates the observations that as the vegetative state ends so the nitrogen content falls and the soluble carbohydrate increases. These figures for C.C.S. show that the canes were normal throughout the growth period unlike those analysed by Wiggins et al (4) which suffered from severe drought symptoms.

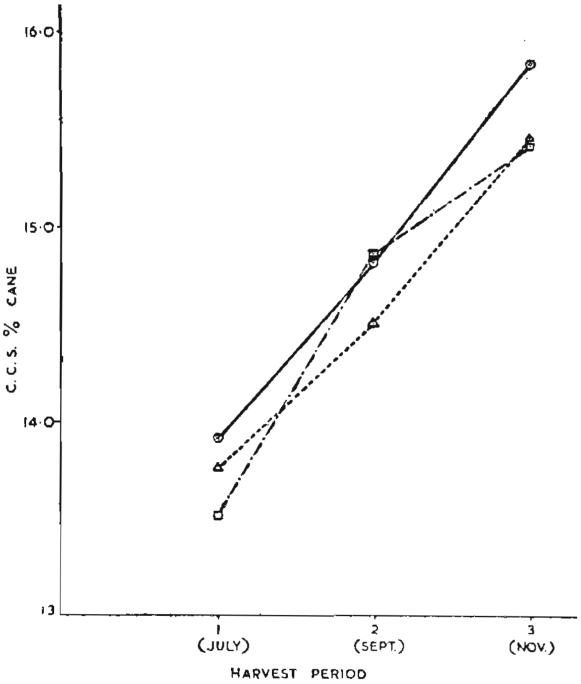


Fig. 15. Effect of nitrogen fertilization and maturity on the C.C.S. % cane. Circles indicate the N1, squares the N2, and triangles the N3, levels of fertilization.

Fig. 14 is a graph showing the influence of fertilization, rainfall district and time of cutting on the amino-acid content of juice. The points are the minimum and the maximum means of six varieties taken at each level of nitrogen. The highest means were all derived from cane grown in a dry district and were all from the first harvest period. The lowest means came from a wetter district and were all from the last harvest period. In all cases increasing nitrogenous fertilization increased the level of total amino-acids.

Thus it would seem that high levels of amino-acids in juice will be encountered when the crop is immature, has received heavy nitrogenous fertilization and has suffered to some extent from dry conditions. Conversely low values of amino-acid in juice can be expected when the crop is mature and is from a district which has received ample water; the effect of nitrogen fertilization if the two former conditions are met would appear to be negligible.

The changes described above are all changes of content in the total juice. It should be noted that due to the increase in the dry matter content of the juice with inereasing age, calculation of the juice nitrogen and amino- acids to a dry matter basis would increase the downward trend of these substances with increasing age.

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2. PHOSPHATE FERTILIZATION

D. H. PARISH, S. M. FEILLAFÉ AND G. ROUILLARD

THE EFFICACITY OF DIFFERENT FORMS OF PHOSPHATIC FERTILIZERS

The practice of using phosphatic materials such as bone, fish and guano as fertilizers is very ancient ; although the last mentioned material was not introduced into Europe until 1839 [Waggaman (1)], it was used by the Incas of Peru long before the Spaniards conquered that country.

Bone was the most important phosphatic fertilizer used in Europe in the eighteenth and early nineteenth centuries and was especially important in England where such large amounts were used that Liebig the noted German chemist is quoted [Rogers et al (2)] as saying: "England is robbing all other countries of the condition of their fertility. Already in her eagerness for bones she has turned up the battlefields of Leipzig, of Waterloo and of the Crimea ; already from the catacombs of Sicily she has carried away the skeletons of many successive generations".

The pressing demand for bone as a fertilizer was relieved to some extent by the use of guano. This material first arrived in London in 1840 from Peru and proved to be so extremely popular that twenty years later the annual exports of guano from Peru had risen to 435,000 tons. Guano and bones continued to be the main sources of phosphatic fertilizers until after the middle of the eighteenth century.

In 1840, [Mellor (3)] the Duke of Richmond stated that the fertilizer value of bones was due not to the gelatin and fat but to the phosphoric acid which they contained ; in the same year, Liebig suggested dissolving bones with sulphuric acid to render the phosphoric acid contained therein more soluble and available to crops. Lawes exploited this discovery by the commercial treatment of phosphates with sulphuric acid to give superphosphate. In addition to bones, low grade mineral phosphates deposits known as coprolites were developed in England for conversion to superphosphate. Following the exploitation of the rich beds of phosphate rock in the U.S.A. and North Africa, superphosphate production increased rapidly and this material was soon to become the major source of fertilizer phosphorous throughout the world.

Superphosphate proved to be an efficient, easily manufactured material with few problems associated with its storage and application. Over the years agronomists have consistently placed superphosphate at the top of the list of the best phosphate carriers with regard to plant response, and it has held this position for a wide range of soil, climatic and crop management conditions. It was to be expected, therefore that superphosphate would come to be universally accepted as a standard against which other phosphatic fertilizers would be evaluated (2).

In sugar producing countries many experiments to assess the effect of phosphatic fertilizers on sugar cane yield and composition have been carried out. In most of the experiments the phosphate was applied in the form of superphosphate, but in several cases the efficacy of different forms of phosphatic fertilizers has been compared [Carey & Robinson (4)].

In Mauritius, guano is the only phosphatic fertilizer used by the sugar industry because of the readily available supplies of this material from neighbouring islands. Although at least 30% of the area under cane is known to be deficient in phosphate, no data on the use of other phosphatic materials are available and it was felt therefore that experiments to compare the efficacy of several forms of phosphate would give results of interest.

EXPERIMENTAL

In 1954 six trials were laid down in areas known to respond to phosphate fertilization. Each trial was a 5x5 latin square, the five treatments being:

(a) control
(b) superphosphate
(c) agrophos
(d) novaphos
(e) phosphatic guano

Agrophos is a tricalcium phosphate material produced from Algerian rock phosphate. Novaphos is a phosphatic guano from the island of Juan de Nova whilst the phosphatic guano of treatment (e) was of the type normally used in Mauritius.

The phosphatic fertilizers were placed in the furrow before planting at a rate of 125 kilogrammes P_2O_5 per arpent. The canes were harvested at about 12 months. Leaf samples for foliar analyses of P_2O_5 and K_2O were taken between 7 and 9 months and at harvest 8th to 10th internodes were dried, milled and analysed for P_2O_5 content.

RESULTS

The yields of cane, five treatments from six trials, are given in Table 6.

Taking the mean figure for the control yields and those for the four treatments it is seen that phosphate fertilization significantly increased the yield of cane over that of the control in all cases. Superphosphate under the conditions of the experiment gave significantly higher responses than the other materials, all three of which appear to be similar in their efficacy.

Table 6. Effect of form of phosphate on cane yield (tons / arpent).

Locality / Treatment	Control (a)	Super-Phosphate (b)	Agrophos (c)	Novaphos (d)	Phosphatic Guano (e)
New Grove	18.8	25.6*	22.1	25.7*	21.8
Riche en Eau	18.4	21.3*	19.2	18.8	18.8
Gros Bois	15.9	24.8‡	20.8‡	20.1‡	19.4*
Hermitage	23.2	25.6	23.7	21.5	22.8
Beau Climat	10.0	28.0‡	25.0‡	24.7‡	23.5‡
Trois Ilots	12.5	17.5‡	15.2*	17.8‡	17.8‡
Mean	16.5	23.8‡	21.0‡	21.4‡	20.7‡
	—	23.8*	21.0	21.4	20.7

‡ *Significant at 1% level.*
* " " *5%* "

Table 7. % Dry matter leaf punch.

	Control (a)	Super-phosphate (b)	Agrophos (c)	Novaphos (d)	E Phosphatic Guano (e)
P_2O_5	0.42	0.44	0.43	0.44	0.44
K_2O	1.59	1.60	1.56	1.62	1.68

The results of the foliar diagnosis analyses (Table 7) showed no marked difference in phosphorous uptake in the different treatments, which may have been due however to inadequate sampling (see page 41) of this report). The potash figures showed that no deficiency of potassium occurred in the experiments, all the figures being well above the considered minimum optimum level of 1.35% K_2O.

The levels of P_2O_5 in the 8th — 10th internodes were erratic and are therefore not presented here.

DISCUSSION

The experimental plots received a high level of phosphatic fertilization i.e. 125 kilogrammes of P_2O_5 per arpent, the reason being that this is standard fertilizer practice in Mauritius. Thus, plant canes normally receive heavy dressings of phosphatic guano applied in the furrow at the time of planting, no further phosphatic fertilizer being applied irrespective of the lengh of the ratooning period, which in Mauritius on the average lasts for six years

In the trials, a comparison has been made of four different phosphatic fertilizers applied at a level which may appear to have been excessive. It is well known that highly contrasted fertilizer material may give similar yields merely because both are used at rates which are high for the conditions tested. The form of the yield curve should be determined [Crowther (5)], at least approximately, in all comparative tests and the comparisons restricted to the steeply rising part of the average curve for a number of experiments. The superphosphate results indicate that the rate of applications of the insoluble phosphates was not excessive, as treatment (b) superphosphate, gave significantly higher yields than treatments (c), (d) and (e), the tricalcium phosphate materials.

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 applications, as well as the method of application and the form of phosphatic fertilizer used.

Ideally, phosphate fertilizers should be applied at rates which result in maximum financial return. This optimum level of fertilization is reached when the value of the increase in crops resulting from a small additional increment of fertilizer is equal to the cost involved in producing the extra increment of yield [Crowther & Yates (6)].

The first requirement, of course, is to establish a firm foundation, based on suitable experimental evidence, for evaluating the various factors involved in obtaining the most effective and efficient use of phosphatic fertilizers.

In several areas of Mauritius a serious decline in the yielding capacity of the ratoons occurs at an early stage necessitating the replanting of the field. It has been demonstrated that despite the large amounts of phosphatic guano applied at planting, phosphate deficiency is one of the factors involved.

This occurrence of phosphate deficiency symptoms in ratoons and the apparent superiority of superphosphate over the other forms of phosphate tested in 1954 warrant the laying down of new phosphate experiments in order to obtain more data.

Recent developments in the use of fertilizers tagged with radioactive phosphorous provide a sensitive method for distinguishing between that portion of the phosphorous in plants derived from the fertilizer and that derived from the native supply in the soil and thus offer another method of evaluating the relative availability of the phosphorous in different materials.

In 1948 a programme of research undertaken by the United States Department of Agriculture to compare the availability of the phosphorous of several different fertilizers under a wide range of conditions showed that superphosphate was the superior form.

It should be clearly recognised however that the tagged atom technique simply provides another tool for use in studying some of the soil-fertilizer-plant relationships which are involved in the utilization of fertilizer phosphorous by plants. In the economic evaluation of fertilizer sources the final answer must be in terms of crop yields obtained on phosphorous deficient soil when used at practical rates of application. (2)

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3. THE EFFECT OF LIME TREATMENT ON SOILS OF THE SUPER-HUMID ZONE.

D. H. PARISH AND S. M. FEILLAFÉ

As reported in the Annual Report for 1954, a response in yield of cane to lime application has been proved to occur on the gravelly soils of the super-humid zone, whilst no responses are obtained on the free soils of the same area.

The analytical data available are limited and it has therefore been decided to carry out a fairly detailed investigation of these two soils in order to establish, if possible, the conditions under which a response to lime application could be expected.

Preliminary data are given in this paper for the pH of the control and limed plots from the two soils (Table 8) and of the titration curves (Fig. 16).

Table 8. pH of Control and limed plots.

	Rose Belle series	Sans Souci series
Control plots	5.8	5.4
Limed plots	6.2	6.1

The pH figure of a soil is in itself of little value, but as Ayres and Hagihara (1) state: "Where something is known regarding the pH-base relationship of a soils and the ultimate pH, this measure of hydrogen ion activity is of inestimable value as a first aproximation of levels of exchangeable calcium and magnesium on soils of low base saturation."

Titration curves help to supply the basic information necessary for a proper interpretation of pH values as well as being a useful aid in classifying and identifying the various great soil groups [Matsusaka & Sherman (2)].

The data given show that although the pH. levels of the two soils with and without

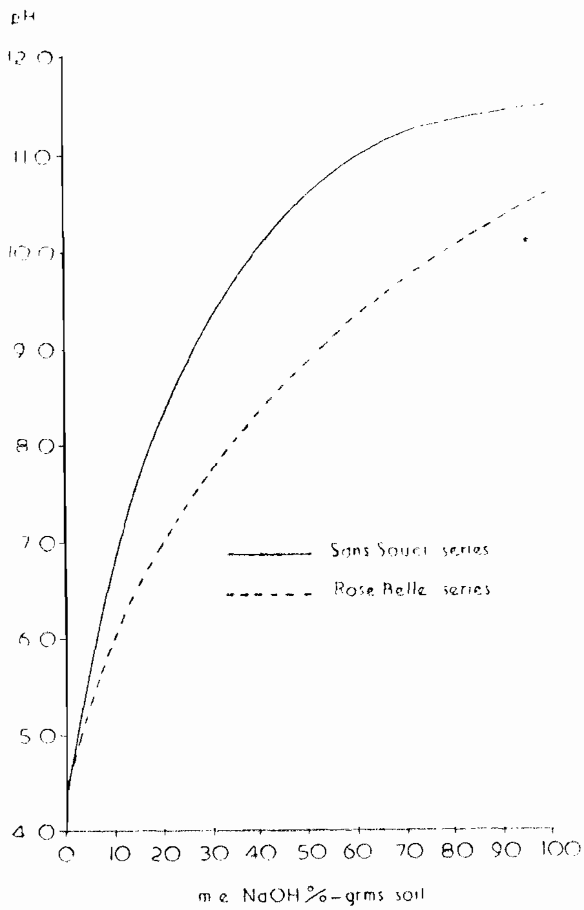

Fig. 16. Titration curves of two soil series of the superhumid zone.

lime treatment are similar, the titration curves distinguish clearly the two soil types, especially at the higher pH levels. The principal factor affecting the shape of the titration curve is that of the type of clay mineral present; the amount of clay being unimportant in tropical soils (2). Organic matter has also an effect, and as the gravelly soils contain considerably more of this material than the free soils, part of the higher buffering capacity of the former soils may be ascribed to this factor.

In the Hawaiian islands, response to lime application can be expected when the level of Ca falls below 100 p.p.m., but the data available for the gravelly soils of Mauritius show a level of Ca far above this figure.

Studies on the base exchange characteristics and other factors possibly connected with the response to lime treatment are in progress, and it is expected to publish the data obtained elsewhere.

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4. FOLIAR DIAGNOSIS

PIERRE HALAIS

Foliar diagnosis has found a permanent place in the agronomy of sugar cane in Mauritius. Some 8,000 different cane fields are being sampled, once a year, on estates and planters' lands and recommendations concerning phosphate and potash fertilization are issued by the Institute at the end of the sugar campaign to approximately 200 fairly large cultural units, after taking due consideration of the relevant analytical data collected over the last three years. Moreover, most of the field trials ·conducted during the past twenty years have been subjected to foliar diagnosis in order to disclose the nutritional factors contributing, (according to the circumstances,) to the best sugar yields.

Within the broad lines described, foliar diagnosis has met with general acceptance in experienced quarters. There is scope for further increase in production through more adequate distribution of available factory residues and imported commercial fertilizers. A fairly large number of fields, or even cultural units, still bear canes that show phosphorous and/or potassium status far below the optimum, thus restraining the action of the inorganic nitrogen applications made annually at high cost. While the correctness of the diagnosis rests on the Agronomist, the implementation of his recommendations, that is the actual improvement of the nutritional status of canes must be carried out by the Industrialist himself if their joint aim of higher and more economical sugar production is to be fulfilled.

Nevertheless more refined rules in leaf sampling should be followed when foliar diagnosis is called upon to deal successfully with smaller cane fields. In short, there is no hope in using at its best this long-sought for guide to cane fertilization if adequate leaf sampling is not being taken seriously. Fortunately enough the leaf punch sampling technique recommended below is simple and well suited to inexpensive repetition in space and time.

A series of blank tests was conducted during 1955 at the four Experiment Stations of the Institute to study the variability of foliar diagnosis data obtained under routine field and laboratory conditions and to find out the appropriate number of replications needed to reach reasonable accuracy.

The results obtained are presented in tables 9 and 10 ; they show clearly that reliable foliar diagnosis data may be obtained provided there are sufficient replications. On the other hand, few foliar diagnosis data, taken isolately, may be quite misleading. In the case studied it is apparent that at least 8 replications are required to reach full significance.

Table 9. Results of a blank-test carried out on 64 pairs of adjacent plots at four stations.

3rd leaf data	Control (average)	B plots (average)	Standard Deviation	Coefficient of variation
N % d. m. l. p.	1.97	1.99	0.09	4.5
P_2O_5 ” ”	0.50	0.50	0.03	6.0
K_2O ” ”	1.96	1·97	0.18	9.0
Vegetative Index (30 blades)	100.0	100.8	5.3	5.3

Table 10. Least significant differences ($P = 0.05$) for different number (n) of replications.

3rd. leaf data	n : = 2	= 4	= 8	= 16	= 32	= 64
N % d. m. l. p.	0.39	0.16	0.10	0.06	0.05	0.03
P_2O_5 ” ”	0.13	0.05	0.03	0.02	0.02	0.01
K_2O ” ”	0.77	0.31	0.19	0.13	0.09	0.06
Vegetative Index (30 blades)	22.8	9.2	5.7	3.8	2.7	1.9

In this connection, the accepted least differences for Nitrogen diagnosis by the differential method corresponding to a fixed additional dose of 20 Kg. N/arpent is 0.10 N % d.m. of the leaf punch coupled with a vegetative index of 105. For Phosphorous and Potassium diagnosis by the direct method with M. 134/32 ratoons 5—7 months old, the optimum is 0.45—0.55 P_2O_5% d.m. of leaf punch (a range of 0.10) and 1.35—1.65 K_2O (a range of 0.30).

General experience after twenty years of theoretical and practical studies on foliar diagnosis in Mauritius, leads to the following recommended leaf sampling procedures.

Leaf-punch sampling for direct P & K foliar diagnosis:

Remove about sixty third leaf blades—counting the one partially unfolded as the first — from primary shoots regularly distributed over the whole field to be studied. The middle 10 cm. portions of these blades are cut and hand-separated into green tissue and midrib, the latter being discarded. The green tissue kept are packed one on top of the other over a piece of rubber and approximately 240 leaf-punches are taken by means of a sharp borer not exceeding 5 mm. in diameter. The fresh leaf-punches are dried as soon as possible in a well ventilated oven during two hours at 80-100° C. The sample is properly labelled and kept for analysis at a later date.

In Mauritius, only ratoons are normally sampled during the summer boom stage of growth at the age of 5 and 7 months and prior to flowering. No sample is taken if the canes are suffering from lack of moisture, from recent effects of strong cyclonic winds, from pests, diseases or impeded drainage. It is highly desirable, for intensive studies, that leaves from each selected field should be sampled at two, or preferably three, monthly intervals during the grand period of growth and that similar sampling be repeated for two, or better three, consecutive years. Such time repetition is necessary to reduce the effect of transitory meteorological influences on leaf composition. Because of the stability of phosphate and potash reserves in soils of Mauritius, the delay thus encountered offers little or no disadvantage when an accurate diagnosis is at stake.

Chemical analysis, by accepted methods,— e.g. Annual Report 1954, M.S.I.R.I. pp. 45-46 — can be conducted each year on the bulk-sample from the two or three monthly sub-samples.

Allowance should be made for the cane variety when interpreting final results after two or three years of studies. Of course the same procedure, in a simplified form, should be repeated, after a lapse of several years, on that same field in order to assess the correctness of the fertilizer practice adopted.

Leaf Sampling for differential N foliar diagnosis.

According to the size of the fields chosen for conducting such intensive studies, fertilize 6 to 12 microplots — four rows of canes, 20 ft. in length — well scattered over the whole area with an extra dose of 20 Kg. N/arpent., additional to regular practice.

Virgin canes should be over and ratoons under three months old. One and two months after the extra Nitrogen has been applied, comparative samples of 3rd. leaf-blades are taken from each extra N micro-plot — 30 blades from the two central rows — and from the adjacent rows of the field control — 15 blades on each lateral side of the extra N micro-plots. The pairs of 30 leaf-blade bundles thus collected are carefully weighed on the spot to find out the vegetative index: green weight of blades from the extra N micro-plots expressed in percentage of the weight of the adjoining control blades. After weighing of the blades is completed, leaf-punch samples should be collected off them as already described. The punches are dried as soon as possible to prevent losses of Nitrogen.

Chemical analysis for Nitrogen, — e. g. Annual Report 1954 M.S.I.R.I. pp. 45-46 — should be made without delay in order that the results obtained may be used immediately.

The interpretation of the differential data is carried out according to the following rules ; the regular field practice is short of Nitrogen fertilization if, on the average, :

(a) the vegetative index of the extra N micro-plots exceeds 105 and at the same time,

(b) the Nitrogen content of the 3rd. leaf-punch from the extra N micro-plots exceeds by 0.10 N% d.m. the content from the field control.

In case a positive response to Nitrogen is proved no time should be lost in applying to the field, as a whole, the extra dose of inorganic Nitrogen needed. This dose may vary from 10 to 30 Kg. N/arpent according to the magnitude of the differences obtained from the foliar data.

Apart from the proper delimitation and labelling of the extra Nitrogen micro-plots for rapid identification in the regular field, the differential method described does not give rise to excessive difficulties and is neither expensive in labour nor in equipment.

CANE DISEASES

R. ANTOINE

1. INTRODUCTION

THE major activity of the division during the year was centered around ratoon stunting disease, a recent addition to the list of sugar cane diseases recorded in the island. The importance of the malady could not be underestimated in a country where sugar cane is grown for a high number of ratoons. It was therefore essential to obtain as much information as possible on the disease in order to be in a position to launch an eradication campaign effectively. The Director and Pathologist visited the Queensland cane belt in May, where with the assistance of the staff of the Bureau of Sugar Experiment Stations, who discovered the disease and initiated the curative treatment, valuable first hand information was obtained on the disease itself, control measures and their applications on a commercial scale, and experimental work in progress.

The second pathological problem in the island is chlorotic streak which is widespread in regions of high rainfall or in localities where soil drainage is defective. Large scale treatment of cuttings at 52°C for 20 minutes in all areas where the disease prevails has overcome the adverse effect on germination. Yet some of the plants derived from the hot water treated setts may exhibit typical leaf symptoms after some time. That may be due to transmission by vectors, to some soil-borne factor, or to a building-up within the sett of the population of the pathogen from the few individuals that may have survived the treatment. Preliminary results have been obtained in experiments designed to study that aspect of the problem.

No outbreak of importance of any major cane disease was observed during the year. In spite of a weak cyclone in February and a drought in October, growth conditions were on the whole favourable. It should be mentioned however that on the "Plaine Lauzun" soil type in the Black River district as a result of the severe drought a bad local outbreak of red rot was observed killing a fair proportion of standing canes. At the factory the extraordinarily low purity of 65 was recorded.

With the cultivation of resistant varieties, gumming, leaf scald and smut are now diseases of the past. It should be mentioned however that this year climatic conditions seem to have been very favourable to the development of gumming disease. *Thysanolaena* was seen severely affected in several localities. As far as leaf scald is concerned, B. 34104 was not released for commercial planting at the same time as the other Barbados varieties on account of its susceptibility to the disease in British Guiana. That variety however having failed to show infection in trials as well as under natural conditions in the island, has now been released. It will however still remain under observation for a time, and the large scale planting of that variety is not at present recommended. Isolated cases of smut were recorded as in previous years in the sub-humid zone.

Another major concern of the division is the outbreak of Fiji disease, in 1954, on the east coast of Madagascar. The fact that the disease is now no longer restricted to the far away South-West Pacific and the high susceptibility of M. 134/32 to the virus represent a potential menace to the sugar industry in the island. Valuable information on the establishment of disease resistance trials and the campaigns conducted to control the disease was obtained during a visit to Australia and Fiji this year. The French authorities are pursuing their vigorous campaign to eradicate the disease in Madagascar and resistance trials have been established. Some of the varieties grown commercially in Mauritius have been included.

2. RATOON STUNTING DISEASE

A survey has shown that the disease, although fairly widespread in the island, seems to be more restricted to the super-humid zone. M. 134/32 was seen severely stunted in patches of varying sizes in several localities, but the characteristic symptoms were not observed on all occasions. On one estate nine months old first ratoons and eight months old virgins of M.134/32 were seen badly stunted in scattered groups. In the case of the ratoon cane it is highly probable that a small percentage of the cuttings was already infected at planting time. Stunting was not conspicuous during the virgin crop but was severe in the ratoons. Canes apparently healthy in the immediate vicinity of the patches were examined and good symptoms were seen. It seems therefore that those canes became infected by the cutting knife at harvest and will most probably show stunting next year. As far as the virgin crop is concerned, the field from which cuttings were taken was surveyed and it was found that some stools in small patches were stunted and the canes when examined showed obvious symptoms.

M.134/32 has been under cultivation in the island for about fifteen years. It probably became contaminated through the cutting knife at the time it was being cultivated side by side with the old standing varieties which it eventually replaced. It is interesting to note that good symptoms and stunting were observed on M.134/32 in one estate in the south of the island where an unidentified seedling, known locally as " canne bambou ", is cultivated on patches of poor shallow soil. What could be recorded as obvious symptoms of ratoon stunting disease were observed on "canne bambou" although so far the normal colour of the bundles in healthy cane is not known. It may well be that large scale infection passed from that variety to M.134/32 through the cutting knife.

It would be very difficult at this stage to divide the island into infected and disease free zones. What is known with certainty is that the leading variety M.134/32 may be severely affected and shows characteristic symptoms in localities where rainfall is above 80 inches per annum. On the other hand, cuttings taken from diseased fields when planted into the drier areas of the island develop into normal plants, which may or may not show symptoms depending upon the time of the year. It is therefore very difficult to carry out a survey in the drier localities of the island.

Ebène 1/37 a cane that has largely replaced M. 134/32 in the wetter localities, seems to be less severely affected and the symptoms shown are rarely very obvious. It is true that the method of spread of the disease through the knives is relatively slow and that Ebène 1/37 has been under cultivation for a much shorter cycle than M. 134/32.

Varieties Co. 419, Co. 421 and D. 109 again showed severe stunting as well as characteristic symptoms, discoloration of the bundles being particularly striking in the last variety (fig. 17). Symptoms of ratoon stunting and chlorotic streak are contrasted in fig. 18. It should also be noted that D. 109 exhibits the pinkish nodal discoloration in mature stalks as well. Comparative plots established with diseased and healthy cuttings of that variety are providing material for chromatographic analyses.

Results obtained in field trials laid down to determine the effect of the disease on M. 134/32 and the efficacy of the hot water treatment in controlling the disease are discussed below.

(a) *Effect of the disease on M. 134/32.*

Three identical trials were laid down towards the end of 1954: one at Union Park Experiment Station, another at Pamplemousses Experiment Station and the third at Réduit Experiment Station.

At Pamplemousses Experiment Station good symptoms were observed when the canes were examined in October and the trial was reaped. However, at Union Park and Réduit no symptoms were seen until December; these two trials were therefore harvested two months later. The results obtained are summarized in table 11.

Table 11. Effect of ratoon stunting on yield of M. 134/32 in different localities.

Location	Rainfall inches p. a.	Age of crop	Yield in tons/arpent		% reduction in yield
			Inoculated	Not Inoculated	
Pamplemousses E. S.	58	10 mths	12.8	14.0	8.6
Réduit E. S.	64	13 mths	21.8	23.4	6.8
Union Park E. S.	125	13 mths	23.8	34.3	30.6

Results given above confirm field observations that M. 134/32 seems to be commercially resistant in localities with an annual rainfall below 80 inches per annum. It should be noted here that in a plot established at Réduit Experiment Station with diseased cuttings, derived from stunted canes in a field in the super-humid region, growth has been normal, in spite of the fact that obvious internal symptoms of the disease were observed. Environmental conditions thus appear to play an important role in the severity of the disease in the island.

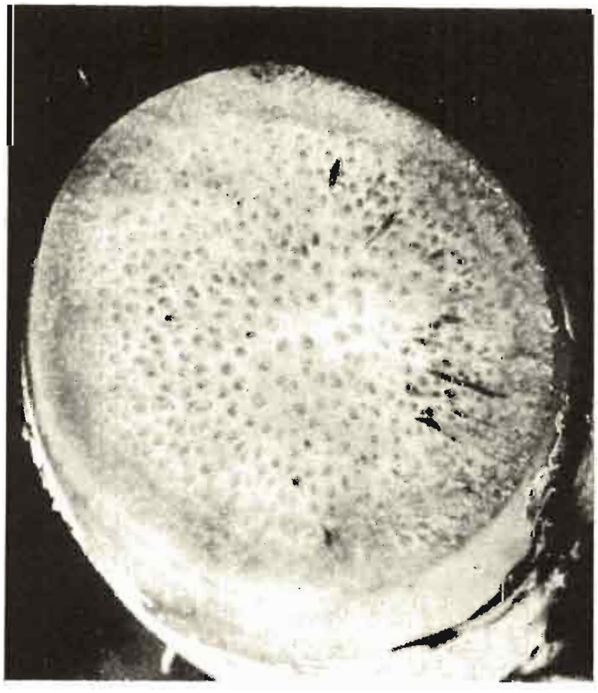

Fig. 17. Transverse section of node of D.109 showing, discoloured vascular bundles caused by ratoon stunting disease.

(b) *Curative heat treatment.*

Experiments of an exploratory nature were laid down in November 1954 to study the efficacy of the recommended hot water treatment (50°C for 2 hours) and the effect of heat on germination of different varieties. The tank used was heated by primus stoves and the water continously agitated by raising and lowering a perforated basket containing the cane cuttings. Temperatures as recorded by an ordinary laboratory thermometer appeared to be fairly constant throughout treatment. Results of germination tests have been published in the 1954 report (p. 48).

In each plot canes from border rows were examined for symptoms. Except at Pamplemousses Experiment Station where typical discoloration of bundles was seen, when the canes were examined in October, symptoms at the other stations appeared only in December at a time when a large number of primary shoots had already been removed for examination.

In all the treated plots symptoms of the disease were observed probably because of inadequate treatment. Results obtained at Pamplemousses Experiment Station after examination of some 3000 nodes, are given in table 12. The six bottom nodes in each stalk were examined and four ratings recorded, ranging from no symptoms at all to obvious symptoms. Stalks showing the first two ratings being considered as healthy and the last two as diseased.

Table 12. Effect of hot water treatment on ratoon stunting disease.

	Control		Hot water treated	
	Inoculated	Not Inoculated	Inoculated before treatment	Not Inoculated before treatment
% canes showing symptoms	22.5	10.0	25.0	6.0
Yield in tons/acre	12.8	14.0	9.4	10.0

It will be noted that some of the cuttings, which were all taken from apparently healthy fields, were infected.

No conclusions could be drawn from the results obtained in trials established with ten commercial varieties on account of poor germination with the result that several recruitings had to be made and the fact that the equipment used was inadequate.

Recommendations made by the Queensland Bureau of Sugar Experiment Stations concerning the heat treatment of cane setts in order to control ratoon stunting were based on tests carried out with variety Q.28. In view of the fact that a fair proportion of diseased cane has been found in plots established locally as well as in various sugar cane countries, whether the treatment used was hot water (50°C for 2 hours) or hot air (54°C for 8 hours), there is ground to believe that the recommended treatments may not cure the disease in all varieties. Two factors are involved : (1) design and equipment of treatment tanks should be such that the operation can be carried out under carefully controlled conditions as the margin for error is very small, (2) one of the variants or both in the time-temperature combination may have to be altered in order to cure the disease in some varieties. An experimental tank that, it is hoped, will answer the first requirement is under construction. The size of the tank will be 8' x 4' x 4'6 and its capacity 700 gallons of water and half a ton of cuttings. It will accommodate two square cages each containing six baskets holding 100 lb. of cuttings. The water : cane ratio will thus be 6 : 1. The tank will be electrically heated by means of 15 stainless steel elements of 5 kw. situated at the bottom of the tank. A 3 HP. electric motor will drive a 2" chokeless pump and provide a circulation cycle of 7 minutes. Incoming water will be forced through outlet holes in 1" pipes on two opposite sides near the top of the tank and the circulation water will return by means of a 2" draw-off pipe situated at the bottom of the tank above the heating elements. Loading will be by means of an electric winch. The tank will be fitted with a thermometer regulator and an indicating thermograph and will be insulated by means of an asbestos composition. As far as the second requirement is concerned, failure of the recommended treatment to cure the disease in all varieties may be due to the botanical nature of the cutting, the thickness of the sett and the existence of heat resistant strains of the virus. It is therefore contemplated to determine temperatures inside the setts by means of a needle themocouple, corresponding to various time-temperature combinations used with different varieties.

Plans have been prepared for the large scale treatment of setts in order to establish in the first year an area of nurseries sufficient to provide disease-free material for planting the total area of virgin canes in the following year. It is estimated, considering the adverse effect of the long hot water treatment upon germination, that provision will have to be made for treatment of 9,000 tons of cane to plant nurseries covering approximately 2000 arpents. It is however not contemplated to recommend the adoption of the large scale hot water treatment of cuttings until more experimental evidence is obtained under local conditions.

It should be noted that planters are getting more and more conscious of the importance of ratoon stunting disease in the island. Temporary measures that will no doubt prevent the disease position from deteriorating further, such as disinfection of knives when cutters pass from one field to the next and during preparation of planting material, and selection of apparently disease-free fields, as source of planting material, have been adopted by several planters in the humid to super-humid regions.

It has been recommended to wash the knives in water in order to remove adhering debris and sugary substances and then immerse and scrub the knives in a solution of " Mirrol " or " Zephirol " containing 0.5% of the active substance, for 15 seconds.

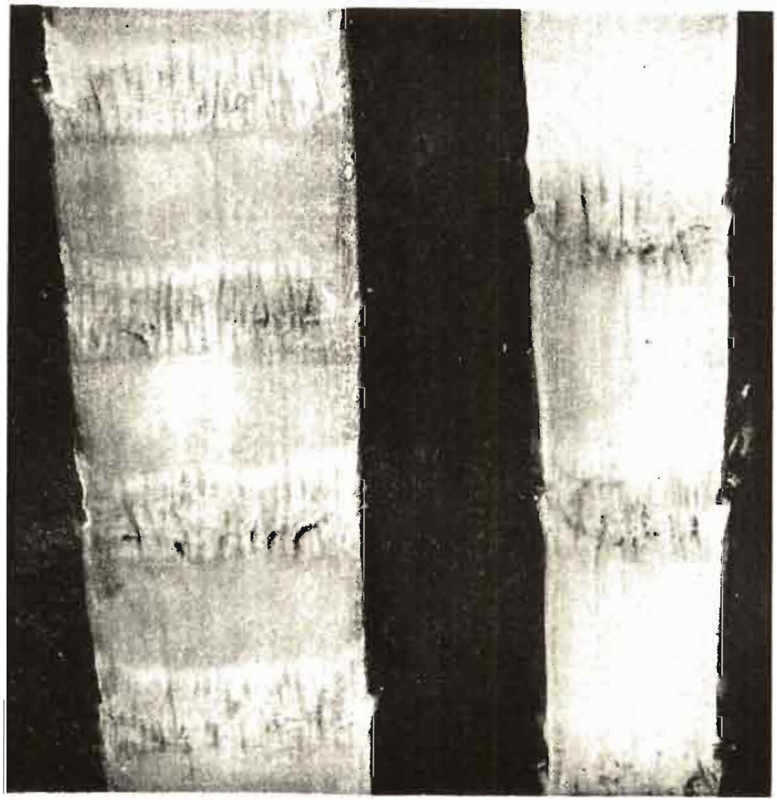

Fig. 18. Longitudinal sections of D.109 (left) infected with ratoon stunting disease, and Ebène 1/37 (right) infected with chlorotic steak.

3. CHEMICAL DIAGNOSIS OF RATOON STUNTING DISEASE

D. H. PARISH

Many reviews on viruses and virus diseases have been published, the most important from the point of view of the present work being the article by Bawden and Pirie (1).

These authors define virus diseases as metabolic disturbances of the host which produce, among other things, more material that can induce similar metabolic changes in other hosts. Few of the known virus diseases have been studied chemically in any detail, but each has involved an aberration of nucleoprotein metabolism. It is reasonable, therefore, to seek anomalies in the nucloproteins, but the search should not stop there, for it would be premature to make the restrictive generalisation that all virus diseases are transmissible aberrations of nucleoprotein metabolism. Any biochemical or physiological studies on infected plants may contribute to an understanding of virus diseases; conversely, knowledge of the plant's reaction to infection may contribute to plant physiology. However, as Bawden and Pirie point out, the study of the metabolic processes and changes involved in virus infection has been neglected, despite the fact that the infectivity of virus particles effectively "labels" them so that they can be specifically assayed in low concentrations. The lack of research on this latter aspect of infection is a handicap as it means that few guiding principles are available; and because no means of assaying ratoon stunting disease virus are known, the difficulties are further enhanced.

One of the problems confronting the pathologist is the correct diagnosis of this disease, as the symptoms are often faint or evanescent and are greatly influenced by varietal and environmental conditions. For this reason the possibility of devising a chemical method of diagnosis is being explored. At the same time work is being carried out on the chemical composition of the varieties grown commercially in Mauritius and when more field data on the resistance of these varieties to ratoon stunting disease is available it may be possible to correlate the levels of certain substances with resistance to this disease. Thus it is known that citric acid reduces the infectivity of tobacco necrosis virus when mixed with the virus *in vitro*. This has led to a study of the concentration of organic acids in French bean leaves [Wiltshire (2)] and although this author states that it is unlikely that resistance to tobacco necrosis virus infection depends completely on the concentration of any one of these acids, it is undoubtedly a possibility that resistance of plants to virus infection may be correlated with variations in some relatively simple group of substances.

There are many known changes in host metabolism that influence virus infections. For example seasonal changes affect virus diseases differently; some, particularly the yellows type, (e.g., potato leaf roll and sugar beet yellows), are severe during summer but slight during winter whereas many of the mosaic type viruses (for example, tobacco etch, potato X and Y and tomato bushy stunt) cause much more severe symptoms in winter than in summer. Differences in light intensity, temperature and nutrition are known to influence to a marked degree the severity of infection with certain viruses. Little, however, is known of the effect of any of these variables on the severity of ratoon stunting disease infection. In this connection it is interesting to note that the Pathologist has shown (page 45) that generally symptoms of ratoon stunting disease in Mauritius are more severe under conditions of high rainfall than under a low rainfall regime.

Several papers have been published on the detection of virus infection of plants by chemical or physical means the most relevant of which are cited here.

Some simple tests have been devised and great accuracy in diagnosis has sometimes been claimed. Shoichi Hirato (3) has stated that adding 0.1% mercuric chloride solution to the juice of potato tubers infected with leaf roll detects three quarters of the infected tubers. Yarwood (4) describes a test in which a red colour (evanescent) is produced on adding sodium sulphite solution to suspensions of infected material. Tinsley and Usher (5) have described a modification of a test suggested by Lindner, Weeks and Kirkpatrick (6), with caustic soda; using this test it is claimed that a diagnosis of swollen shoot infection of cacao can be made before any external symptoms are apparent.

The discovery that fluorescent substances accumulate in the tissues of virus infected plants [Andreae (7) and Best (8)] has led to the practice of examining seed potatoes under ultraviolet light. Discarding fluorescent tubers may prove useful in reducing the incidence of infection by leaf roll and other types of virus.

Many of these simple tests have been tried in this laboratory using leaf extracts of infected D.109 canes but, despite several modifications, have proved unreliable.

The possibility of detecting virus infection by the specific assay of certain substances has also received some attention. With the advent of paper chromatography it is now possible to separate the amino compounds of plants quite simply and as viruses appear to be produced by aberrations of nitrogen metabolism it was reasonable to examine the amino acid distribution of plants in order to see if any deviations from normal occured on virus infection.

Andreae and Thompson (9) examined the amino-acid composition of normal and leaf-roll infected potato tubers and concluded that the differences in tryptophane and tyrosine content between healthy and diseased tubers held promise of becoming the basis of a simple chemical test for the diagnosis of leaf-roll infection. Allison (10) in an examination of the tubers of six varieties of potatoes concluded that differences in glutamic acid and glutamine contents were more consistent than the tryptophane and tyrosine changes in detecting infected material.

Diener and Dekker (11) in their investigations of virus-induced metabolic changes in stone fruit tissues showed that pipecolic acid, although probably a normal metabolite of peach leaf tissue accumulates in considerable amounts if the tissue suffers from certain disorders such as Western-X disease or arsenic injury.

The work of Commoner and Dietz (13), however,in which they studied the effect of tobacco mosaic synthesis on the soluble nitrogen compounds of leaves, indicated that the mosaic virus protein, like any other plant protein may be formed *de nova* from ammonia and nitrogen-free carbon compounds, in which case no general effect on the free amino-acids present could be expected. Variations in the concentration of individual acids due to virus synthesis would also seem unlikely to occur.

In view of the foregoing work attempts were made in this laboratory in 1955 to detect infection of sugar cane by ratoon stunting disease using chromatographic examination firstly of the ninhydrin reacting materials and later of those substances showing fluorescence under ultra-violet light.

The solvent used in all cases was 4 parts n-butanol: 1 part acetic acid: 5 parts water. Chromatograms were made by spotting juice taken from the growing point and from the first fully developed nodes and internodes directly on to the paper. The separation obtained was good, there being no excessive ' tailing ' of the spots. Elution was carried out for twenty-four hours, the chromatograms then being dried and examined under ultra-violet light (Wood's filter) or sprayed with the ninhydrin reagent of Williams and Wiggins (12). Examination was also made of the leaf tissue using the method of Lindner et al. (loc. cit.).

The material used was young cane of about 4—6 months, grown from hot-water treated setts (50°C for 2 hours) and from setts inoculated at planting with ratoon stunting disease infected juice.

Examination of the ninhydrin sprayed chromatograms showed the presence of fourteen well defined spots which, irrespective of whether the plants were ratoon stunting disease infected or not, appeared to be quantitatively similar.

Examination of the chromatograms under ultra-violet light initially gave encouraging results. About eleven spots could be detected on the chromatograms and some marked quantitative differences between infected and non-infected material were observed. A green spot Rf 0.64 and a blue spot Rf 0.71 were almost completely absent in the supposedly infected material and very marked in the supposedly healthy material. This work was carried out in April 1955 and, although these differences between the chromatograms from infected and non-infected plants were observed many times, it has since proved impossible to repeat them.

There is evidence that the accepted treatment of cane setts in hot water at 50°C for 2 hours is not entirely efficient. These investigations, therefore, will be continued once the time/temperature limits of inactivation of the virus are more clearly defined.

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4. CHLOROTIC STREAK.

R. ANTOINE

Plants derived from cuttings treated in hot water at 52°C for 20 minutes may show disease symptoms some time after planting. Accepting that the hot water treatment destroys the pathogen in the setts, then there must be some active agent at work transmitting the disease as there is ample evidence of secondary infection in certain localities. Experiments carried out by the Entomologist of the Department of Agriculture in the search for a vector having so far yielded negative results, have been discontinued until evidence that would justify a resumption of transmission experiments with insects is obtained.

Two 6 x 6 latin square experiments were established at Belle Rive and Union Park in order to determine the rates of secondary infection in three varieties. The two Experiment Stations are located in the super-humid zone where environmental conditions are favourable to the disease. Although the experiments have been designed to run over two years, preliminary results obtained are probably of sufficient interest to justify inclusion in this report.

The three varieties studied were Ebène 1/37, M. 134/32 and B. 3337. Plantings were made at two months intervals over one year starting in November 1954. Each plot consisted of three double rows, one for each variety. Four stools were established per row, each stool originating from a three-eyed cutting treated at 52°C for 20 minutes. Examinations were made at monthly intervals. Each individual stool was numbered and records of leaves and shoots showing symptoms were kept. In the last survey 1,728 stools were examined at the two stations.

The results given in Figs. 19, 20, 21 and in Table 13 were all obtained in the experiment at Belle Rive. The shoot count, (Figs. 19, 20,) as well as the leaf count give an indication of the manifestation of symptoms throughout the year. The rate of secondary infection should be determined by the stool count, i. e. once symptoms have been recorded in a stool, even if they disappear later, that stool is considered as being infected. Normally symptoms reappear in stools recorded as diseased during the peak period found this year to be October in the November 1954 plantings.

Fig 20. Rate of secondary infection by chlorotic streak as determined by shoots counts in plantings made at two months intervals.
↑ : Time of planting.

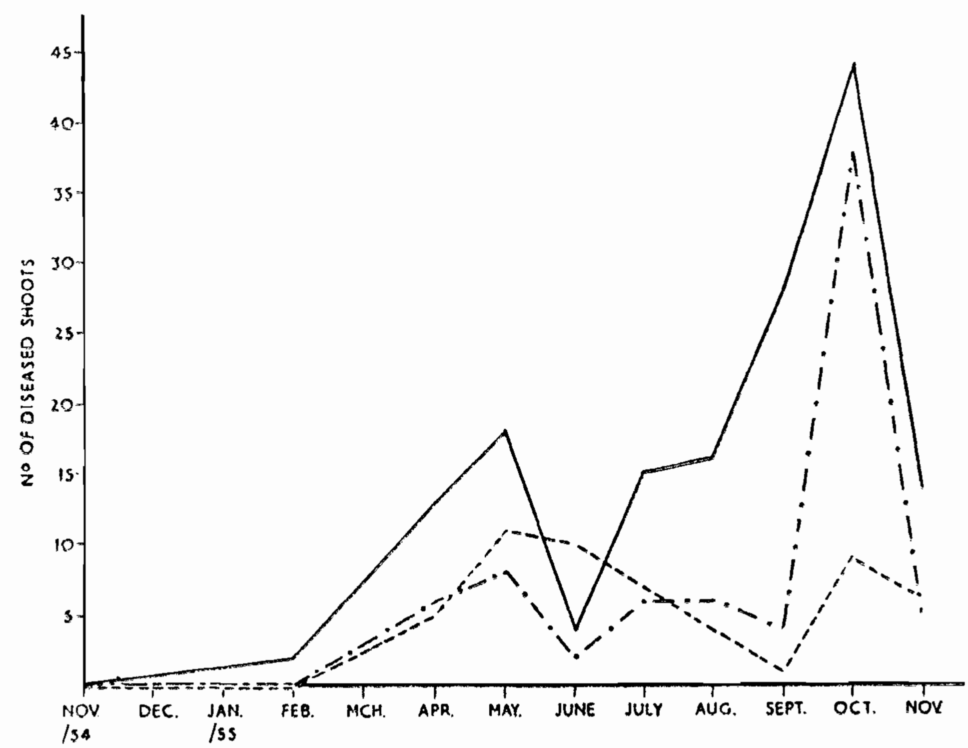

Fig. 19. Rate of secondary infection by chlorotic streak as determined by shoot counts in three varieties. Plain line: Ebène 1/37, broken line: B. 3337, broken and dots: M. 134/32.

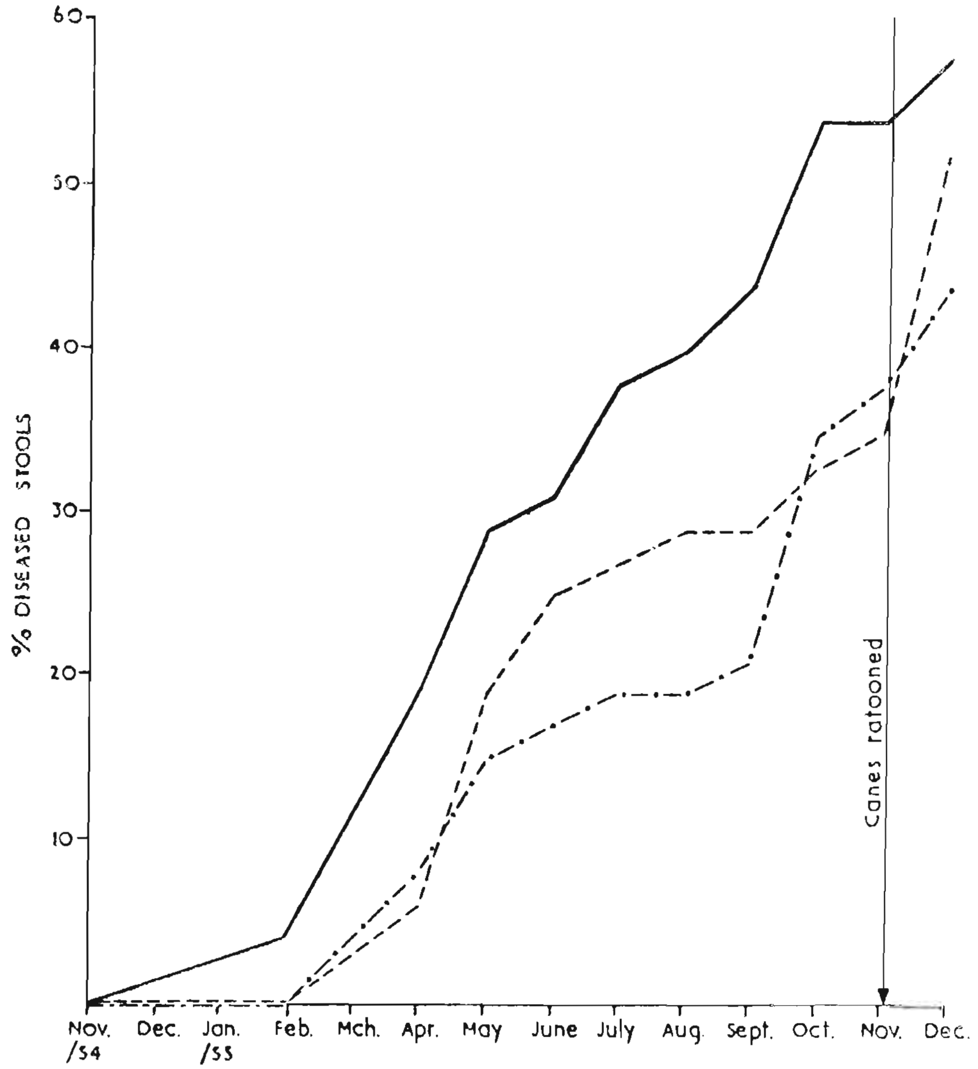

Fig. 21. Rate of secondary infection by chlorotic streak as determined by stool counts in three varieties. Plain line : Ebène 1/37, broken line : B. 3337, broken and dots: M. 134/32.

The preliminary results obtained are summarized below:

(1) Cane derived from hot water treated cuttings acquire the disease rapidly under favourable environmental conditions, about 25% of the stools becoming infected after 6 months and 50% after 12 months. (Fig. 21). These apply to November plantings; there are indications, (Fig. 20), that time of planting may play an important part in secondary infection. It does not seem so far that the plants acquire the disease at one particular time.

(2) On the basis of abundance of leaf symptoms and number of affected shoots, the susceptibilities of the three leading varieties of the super-humid zone are in the following order: Ebène 1/37, M.134/32 and B.3337. As far as the stool count is concerned there is not much difference between the latter two varieties. (Fig. 21). After ratooning however, both expression of symptoms and stool infection increased considerably in B.3337 (table 13).

(3) When the layout of the trial is considered, with only four stools per

Table 13. Incidence of chlorotic streak in cane derived from hot water treated cuttings before and after ratooning.

Variety	% infected stools:	
	before ratooning	after ratooning
Ebène 1/37	54	58
M.134/32	38	44
B.3337	53	52

ten foot row and all the spaces between plots, 50% infection in plant cane after 12 months is a high rate.

(4) Two identical trials were planted at Belle Rive and Union Park under similar environmental conditions favourable to the disease. Whereas abundant symptoms were observed at the first station, not a single leaf showed any striping during the whole year at the other station. Cuttings having been treated under similar conditions, it would appear that the pathogen is completely inactivated by the heat treatment, a fact which is brought out by the complete absence of symptoms at Union Park. The same would apply to Belle Rive, but there however, it would seem that there is an active transmission agent, the plants acquiring the disease in a short time. The only difference between the two trials is that at Belle Rive standing canes were harvested in August 1954, stubbles were uprooted and the trial planted in September 1954. At Union Park however, canes were harvested in August 1953, the field was then abandoned and became invaded by weeds. Stubbles were uprooted in February 1954 and the trial planted in September 1954. Thus, at Belle Rive, cane was planted upon cane, whereas at Union Park a seven months' fallow was taken. The results obtained at the two stations suggest the agency of some soil-borne factor rather than aerial transmission.

5. RED STRIPE.

Four surveys were carried out at the beginning of the year in a field where the disease was first recorded. The results of counts made are given in Table 14.

On an average 645 shoots of B. 3337 were counted per 150 ft. of row as compared to 405 of B. 37161. In spite of the occcurence of a mild cyclone that provided optimal conditions for transmission of the bacterium at the beginning of the year, the disease did not spread. In fact, there was a tendency for symptoms to disappear after the old striped leaves had been shed and leaf striping became less severe. In the majority of cases of new infection few stripes, or single short ones, were observed on the leaves. It should also be noted that not a single case of top rot was observed, only two shoots showed partial rotting of the young leaves. Furthermore, the total infection of 27.4% in B. 37161 is, strictly speaking not correct on account of disappearance of symptoms. Cane yield in the affected field was normal for the locality.

Table 14. Results of surveys in field affected by red stripe.

(a) Shoots counted and cut.

Date	No. of shoots showing leaf symptoms on 150 ft of row		% shoots with infected leaves	
	B. 3337	B. 37161	B. 3337	B. 37161
11.1.55	0	40	0	9.9
1.2.55	4	23	0.6	5.7
24.2.55	3	32	0.5	7.9
17.3.55	8	16	1.2	3.8
Total	15	111	2.3	27.4

(b) Shoots counted only.

11.1.55	12	28	1.9	6.9
1.2.55	10	53	1.6	13.1
24.2.55	20	36	3.1	8.9
17.3.55	25	14	3.9	3.5

Fig. 22. Symtoms of red stripe on *Paspalum nutans* occuring as a weed in an infected cane field.

The disease has been observed on several estates always in a mild form. Varieties seen affected, are: B. 3337, B. 37161, B. 37172 and only one case was observed on Ebène 1/37. Red stripe has not been seen so far on wild grasses in forest regions outside the cane zone. Symptoms on *Paspalum nutans* occurring as a weed in a cane field are shown in (Fig. 22). The disease is proving of minor importance and no special control measures are contemplated at present.

6. DETERIORATION OF MERCURIAL FUNGICIDES IN HOT WATER TANKS.

The deterioration of mercurial fungicides in hot water tanks was studied again this year, the aim being to obtain a fungicide sufficiently stable to be added in the hot bath.

Heat treatment of cuttings kills some of the surface cells and therefore renders the setts more susceptible to invasion by soil micro-organisms. The cuttings must therefore be protected by fungicides, after treatment, specially against pineapple disease.

On one estate where the short hot water treatment is practised against chlorotic streak, a high percentage of setts failed to germinate after treatment. The failure is due to the fact that there was a time lag between heat and fungicidal treatments. One solution would be to incorporate the fungicide in the bath. Experiments carried out in a small laboratory tank with two well known mercurials have shown that their rates of deterioration are the same. Results are shown graphically in fig. 23. It should be mentioned that only two 2-hour treatments at 50°C were carried out per day and that the canes treated were on the whole clean. That accounts no doubt for the slow rate of decomposition as compared to that observed when one of the fungicides was tested under normal working conditions. Until new experimental evidence is obtained, it is recommended that cuttings be dipped in a cold mercurial solution after heat treatment, the dipping however should be carried out immediately after removal of the canes from the hot bath.

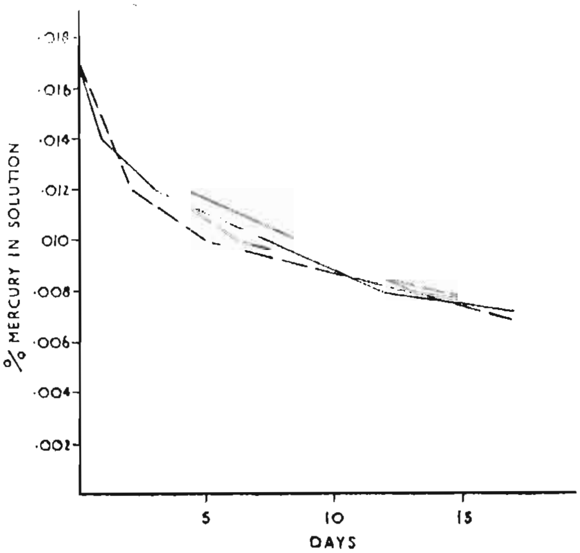

Fig. 23. Rates of deterioration of two organo-mercurial fungicides in hot water bath.

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7. CHEMICAL ROGUEING OF SUGARCANE

E. ROCHECOUSTE

A rapid and efficient method of getting rid *in situ* of sugarcane plants infected with some disease which can spread easily to healthy cane stools is a desirable control measure since the handling of diseased material is thus avoided. The recent discovery of Fiji disease of sugarcane in Madagascar constitutes a potential danger to Mauritius. This has led the Institute to carry out investigations on the chemical rogueing of sugarcane. Preliminary trials laid down in 1954 with TCA and pentachlorophenol showed that TCA is more effective when applied on stumps of cut canes than when applied direct on standing canes. It was also found that a quick scorching of cut canes and green tops is obtained when these are sprayed with pentachlorophenol emulsifiable solution. Following up the work done in 1954, two experiments were carried out this year with a view to studying (i) the efficacy of the TCA treatment for a given quantity of that herbicide when varying volumes of water are used, (ii) the best way of handling the cut canes and green tops in order to reduce to a minimum the emergence of tillers from the cane stumps.

Experiment I.

Method: The experiment was laid down on ratoon canes about 3 months old of an average height of 3 feet. The canes were cut as close to the ground as possible and the stumps chopped with a sharp knife. The cut canes were spread on the ground and sprayed with a 15% emulsifiable pentachlorophenol solution at the rate of 2 gallons in 45 gallons water. When the shoots had been sprayed on one side they were turned over and sprayed on the other in order to ensure a thorough wetting with the pentachlorophenol emulsion. All the sprayed material was then placed on the interlines and allowed to dry.

TCA was applied at four levels 100, 150, 200 and 250 grams for each 10 feet of cane row and each level was used with four dilutions 2, 3, 4 and 5 litres of water. New tillers formed were recorded at weekly intervals and every tiller was tagged in order to follow its subsequent behaviour. The treatments were randomised with fourfold replications and plot size consisted of one row of cane 10 feet long.

Results: Many tillers were at the "spike" stage in the experimental plots and although they were cut as close as possible to the ground, it happened that in many cases the growing points of these young shoots were not damaged and therefore continued to grow temporarily. In the data shown in table 15 the number of tillers produced is therefore differentiated into those that develop from cut tillers and those that develop from new buds.

It was found that the volume of water did not affect killing of the stools and comparable results were obtained with the lower and higher volumes used. Consequently data presented in table 15 include only those obtained with different amounts of TCA dissolved in 2 litres of water.

It appears from these results that 100 grams treatment is not recommendable in any of the above dilutions since about three months after the treatment the canes recover their vigour and begin growth over again. It must also be pointed out that all tillers are produced in the first fortnight following the spraying. It was also observed that shoots arising from cut tillers rarely unroll their leaves, the spindles protruding through the cut leaf sheaths are chlorotic at first, turn yellow and die. On the other hand the shoots arising from new buds, grow more vigorously at first but die within the first months.

Table 15. Summary of the effects of TCA on stumps of cut canes in terms of tiller production.

Treatment per 10 ft. cane row	Tillers in 40 feet cane row after :							
	2 weeks		1 month		2 months		3 months	
TCA (grams) in 2 litres water	from cut tillers	from new buds	from cut tillers	from new buds	from cut tillers	from new buds	from cut tillers	from new buds
100	21	30	10	19	1	11	1	14
150	33	9	10	0	1	1	0	0
200	35	5	16	0	0	0	0	0
250	22	15	8	0	0	1	0	0

Experiment II.

In this second experiment the canes were about six months old and consequently young tillers that could be cut without damaging their growing points were practically absent. The cut canes and green tops were disposed in two ways after they had been sprayed with pentachlorophenol emulsion. In one series they were placed directly on the cane stumps in order to determine whether they would not smother the developing shoots before their emergence. In the other series the canes and green tops were placed along the interlines as in the previous experiment. The four levels of TCA were changed to 150, 175, 200 and 225 grams and each was applied in 2 litres of water. Apart from these alterations the layout of this experiment remained essentially the same. The results obtained are shown in table 16 from which it may be observed that the piling up of cut canes and green tops on the stumps give varying results. Concerning concentration to be applied, it appears that the most efficient and economic treatment is 150 grams TCA in 2 litres of water per 10—foot length of row.

Table 16. Summary of the effect of TCA on stumps of cut canes in terms of tiller formation.

Treatment per 10 ft. cane row	Tillers in 40 ft. cane row							
	Cut canes spread on interlines				Cut canes piled up on stumps			
TCA (grs) in 2 litre of water	2 wks	1 mth	2 mths	3 mths	2 wks	1 mth	2 mths	3 mths
100	3	1	0	0	0	0	0	0
175	3	0	0	0	0	6	15	11
200	2	0	0	0	0	0	0	0
225	0	0	0	0	0	0	0	0

General Conclusions

From the data obtained the following main conclusions can be drawn with regard to chemical rogueing of sugar cane with TCA and pentachlorophenol.

(a) Canes should be cut as close to the ground as possible and the stumps chopped with a sharp knife.

(b) The stumps should be sprayed with TCA at the rate of 150 grams per 2 litres of water for 10 ft. cane row. This is equivalent to approximately 30 grams TCA per stool of cane.

(c) The cut canes should be placed on the interlines and sprayed with a 15% emulsifiable pentachlorophenol emulsion at the rate of 2 gallons in 45 gallons water. When the canes have been sprayed on one side they should be turned over and sprayed on the other until a thorough wetting of the foliage is obtained.

(d) The treated stools should be inspected about a fortnight after the TCA treatment in order to destroy any tiller that may have escaped the treatment.

WEED CONTROL

E. ROCHECOUSTE

1. HERBICIDE TREATMENT OF FIELDS TO BE REPLANTED

CANE fields which are to be planted are generally treated with a mixed herbicide so as to extend the herbicidal action to a wider range of weed species. This operation is of great importance, since on its success depends the degree of re-infestation of a field after planting. Although a mixture of TCA (60 lbs.) and sodium chlorate (40 lbs.) per arpent has been found to give satisfactory results, yet it was felt that further information was needed with regard to the effects of the mixture on different weed communities occurring in various climatic zones of the island.

Two other points also needed further investigation :

(i) the relative merits of adding an hormone weed killer to a mixed herbicide spray such as TCA— Sodium chlorate ;

(ii) herbicidal treatment of fields to be planted in relation to ploughing operations.

Consequently a series of 8 trials was carried out with these aims in view and the results obtained are summarised below.

(a) *Application of mixed herbicides with and without an hormone constituent.*

In selecting fields for these trials much attention was paid to choose those which were infested with a weed population typical of the locality. Further, these experiments were laid down in fields covered with a dense vegetation, in comparison with fields where the weed population was relatively of lesser density. The aim in view was to study the efficacy of herbicidal mixtures in the presence and absence of an hormone, in relation to the density of the weed population at the time of spraying.

Method : An hormone weed killer (MCPA or 2, 4—D) was added to the spray solution of a mixture of herbicides consisting of TCA and sodium chlorate or TCA and pentachlorophenol (15% emulsifiable solution) and these mixtures were compared to other formulations of exactly similar composition but in which the hormone herbicides was omitted. The mixed herbicides were applied on fields with weed populations of different density. The following mixtures were used in 22 different combinations :

(i) TCA : (20—60 lbs.) per arpent.
Sodium chlorate : (20—60 lbs.) per arpent.
Hormone weed killer : 4 lbs. acid equivalent per arpent.

(ii) As above with hormone weed killer omitted.

(iii) TCA · (20—60 lbs.) per arpent.
Pentachlorophenol : (1—1½ gallons) per arpent.
Hormone weed killer : 4 lbs. acid equivalent per arpent.

(iv) As (iii) with hormone weed killer omitted.

Observations were made at 3 and 8 weeks after spraying and the efficacy of the hormone weed killer in the spray solution was assessed according to the degree of re-infestation of the field from seeds.

Results : From the data obtained the following observations emerge :

(i) When annual and perennial grasses form the dominant vegetation the combination TCA at 60 lbs. per arpent and sodium chlorate at 40 lbs. per arpent gave the best results; on the other hand a very good control with TCA at 30 lbs. and sodium chlorate at 60 lbs. was obtained when a mixed weed population occurred in the experimental plots.

(ii) When the spray solution was applied on a field covered with a dense vegetation, the addition of an hormone weed killer was not found to increase the efficacy of the mixture. It was evident that a great proportion of the herbicidal spray did not reach the soil surface. Thus, new growth starting from seeds, was as high in plots treated with the hormone herbicide as that in other plots. On the other hand, in fields with a relatively less dense cover of weeds, the degree of re-infestation from seeds was relatively low when an hormone was added to the spray solution.

(b) Ploughing in relation to herbicidal treatment

The application of a mixture of TCA (60 lbs.) and sodium chlorate (40 lbs.) is used at present on many sugar estates and in general, fields are ploughed for planting about 10 weeks after application of the mixed herbicide. It has been observed, however, that when a field has a dense cover of weeds this method was not entirely satisfactory. In the first weeks following the treatment a great number of weed seedlings are generally found growing beneath the overlying weed cover, presumably owing to better growth conditions becoming available. Of this second generation, composed mostly of annuals and occurring at a lower stratum, many individuals survive. It was therefore thought that ploughing the field with a rotary hoe before spraying the herbicide and also addition of an hormone weed killer to the spray solution might improve the efficacy of the treatment. In the experiments laid down to investigate these points spraying was done a fortnight after ploughing with a rotary hoe at a time when reinfestation had just begun.

Method: In selecting fields for these experiments care was taken to avoid those badly infested with perennial grasses such as *Cynodon dactylon*, "chiendent" and *Phalaris arundinacea*, "Mackaye", since such weeds need special treatment when they do occur in a field. Plots were ploughed with a rotary hoe according to estate practice. The spray consisted of TCA and sodium chlorate mixed in 10 different combinations with and without the addition of an hormone weedkiller.

Results: From the data obtained it was established that when spraying followed ploughing with rotary hoe a better control of weeds was obtained. In the ploughed plots addition of an hormone weed killer increased the efficacy of the treatment in checking weed growth from seeds. Further experiments on ploughed land showed that satisfactory control was obtained at levels of 30 or 40 lbs. TCA in the mixture.

Table 17. Weed infestation in fields treated with different concentrations of TCA in herbicidal mixtures.

Treatment	Weed infestation in % Control	
	Pre-spraying	After 8 weeks
40 lbs TCA + 30 lbs. Sod. chl. + 4 lbs MCPA	110	26
30 lbs TCA + 20 lbs. Sod. chl. + 4 lbs. MCPA	100	34
20 lbs —do— —do—	105	39
20 lbs TCA + 10 lbs. Sod. chl. + 4 lbs. MCPA	100	48

General Conclusions

From the data obtained in these trials it is concluded that it would be difficult to recommend one formulation that would give satisfaction in all cases. The weed flora and its density are factors of importance in selecting an herbicidal mixture. Ploughing with a rotary hoe before spraying has been found to improve markedly the efficacy of the treatment. In addition better results are obtained by the addition of an hormone to the spray solution. A tentative scheme for the treatment of fields to be planted is presented in fig. 24.

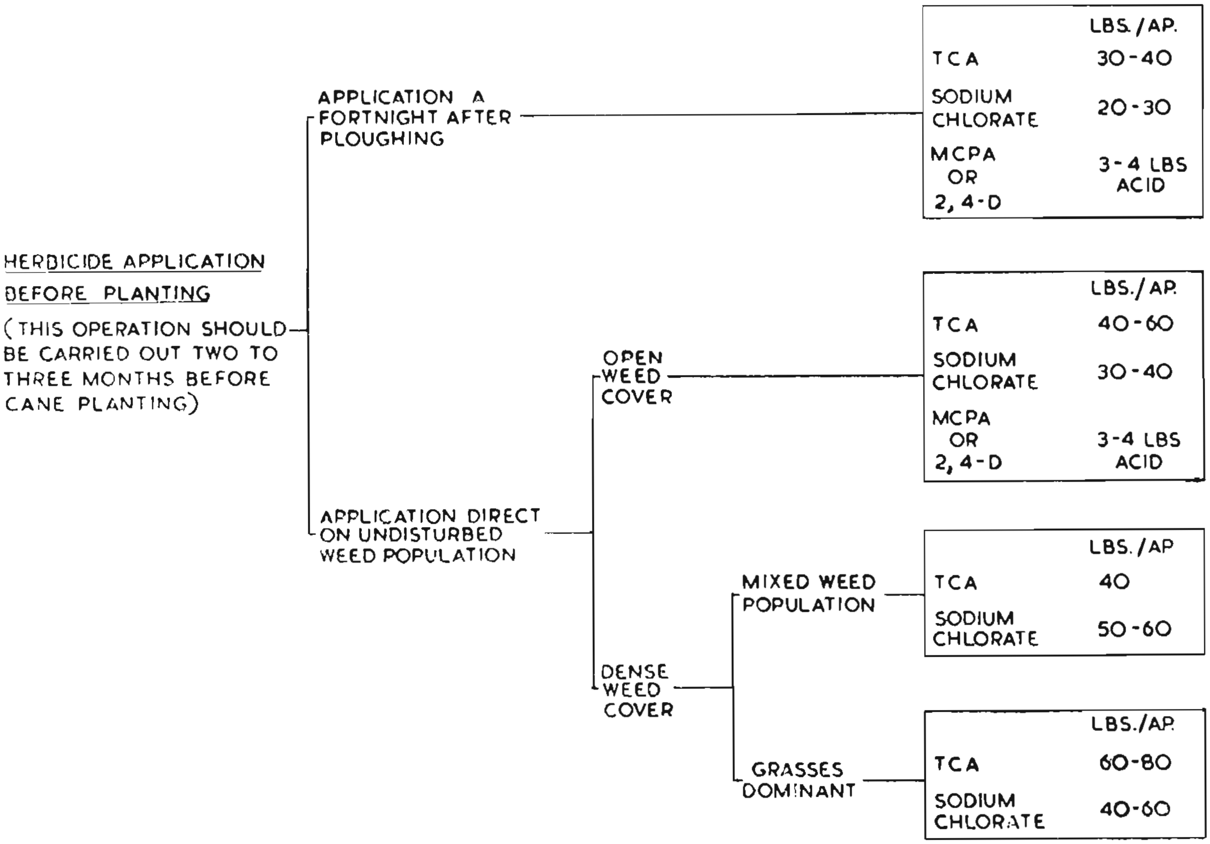

Fig 24. Tentative scheme for control of weeds in fields to be planted.

2. HERBICIDE TREATMENT OF FIELDS BEFORE CANE EMERGENCE

Chemical treatment of cane fields immediately after planting is an important agricultural operation because a toxic material is brought into contact with plant canes during the early phase of their development. Any error in formulation may lead to serious disorders in the further development of the plant which may affect yields adversely. With the great variety of weed killers on the local market it is, at times, difficult to decide what herbicide should be applied and whether it would be preferable to use it alone or in combination with others. Further, planting practice varies on sugar estates and consequently different field conditions occur at time of spraying. It was therefore felt that some experimental work was desirable in order to determine the factors affecting the herbicide treatment of fields before cane emergence under Mauritius conditions and the herbicide or mixture of herbicides more likely to give satisfactory results.

Experimental work

Materials and Method : Nine trials were established in different localities of the island, differing in soil types and climatic conditions. The herbicides used were:

(i) MCPA: potassium salt — (Agroxone).

(ii) 2,4-D : dimethylamine — (Palormone, Monsanto, Phordencs, Hedonal).

(iii) 2,4-D : butoxyethanol ester — Weedone LV4

(iv) TCA : Sodium trichloracetate.

(v) Pentachlorophenol : 15% emulsifiable solution.

(vi) Sodium chlorate.

MCPA and 2, 4—D were used alone at the rate of 3—4 lbs. acid per arpent and also at these rates in combination with the undermentioned herbicides at the following rates per arpent :

(i) Pentachlorophenol : ½—1½ gallons.

(ii) ″ ½ — ″ ″ *plus* TCA 5 : 10 lbs

(iii) Sodium chlorate : 5—10 lbs

(iv) ″ ″ : 5—10 lbs *plus* TCA 5 : 10 lbs

(v) TCA 5 : 10 lbs

Plot size was 1/40th arpent and the treatments were randomised with fourfold replications. Spray solution was kept at a standard rate of 60 gallons per arpent and in all trials the experimental plots were sprayed about a week after planting. It must be emphasized also that in carrying these experiments, fields representing the more common planting practice were selected and that in no circumstances special land preparation was made in the experimental plots.

Results: None of the mixtures used in these experiments had a deleterious effect on cane growth. A scorching effect, however, occurred when cane cuttings were exposed to the action of the contact herbicides. It was also established that a mixture of herbicides consisting of an hormone weed killer together with another herbicide was justifiable only under certain field conditions which existed at the time the spraying was made. Summarised observations on the results obtained are presented in table 18.

Conclusions

From the data obtained it was established that the condition of the field at the time spraying is made is the factor which determines whether an hormone herbicide should be used alone or in combination , with other herbicides, when an herbicidal spray is made before cane emergence. With g o o d land preparation it does not seem advantageous to add any other herbicide to the hormone weedkillers provided canes are planted as soon as possible after tillage operations. If planting is delayed, addition of a contact herbicide such as sodium chlorate improves the efficacy in killing a larger proportion of weeds which are then at an early phase of development.

Table 18. Herbicide application before cane emergence in relation to planting practice.

Planting Practice	Field conditions at time of spraying	Observations
a. Stumps uprooted and field allowed to bare fallow 3-6 months. Field furrowed before planting.	Uprooted stumps and perennial weeds occur on the interlines. These are partially covered with a layer of soil during furrowing operations.	Neither the hormone weed killers used alone nor in combination with other herbicides gave satisfactory results. Field is rapidly invaded by perennial weeds. Owing to poor soil preparation many seeds of annuals are not roached by the herbicides, a condition which contributes to the rapid re-infestation of the field.
b. Stumps uprooted and field allowed to bare fallow 3-6 months. Field ploughed before furrowing.	Clods and rhizomes of perennial weeds occur on the interlines. They are partially covered with a layer of soil during furrowing operations.	Variable results depending upon soil preparation. Sodium chlorate, TCA and PCP were not found to give better control when mixed with the hormone herbicides.
c. Field burnt, cross ploughed with a rotary hoe and furrowed immediately after harvest. Planting delayed for 2-3 weeks.	Excellent soil preparation but grasses and broad leaved weeds at early stage of development.	A mixed herbicide was found to give very satisfactory results. MCPA and amine salts (3-4 lbs acid per Ap.) with 5-10 lbs. sodium chlorate or 3/4 — 1 gallon pentachlorophenol gave excellent weed control. When grasses are not abundant 2,4-D ester (butoxy ethanol) at the rate of 3 lbs. acid per Ap. also gives satisfaction. Addition of 5-10 lbs. TCA to the mixture has apparently a beneficial effect in fields where grasses are dominant.
d. Field burnt, cross ploughed with a rotary hoe, furrowed and planted immediately.	Excellent soil preparation and ideal conditions for pre-emergence spraying.	Hormone weed killers at the rate of 3-4 lbs. acid per Ap. gave as good results as any of the other combinations.

3. PRELIMINARY INVESTIGATIONS ON THE USE OF SUBSTITUTED UREAS

Of herbicides developed during these recent years the substituted ureas are among those that have received more attention in weed control research owing to their potency as weed killing agents. In Hawaii extensive investigations have been done on the use of CMU, one of the members of this class of compounds, and it has been claimed that no harmful effects are obtained on canes when pre-emergence applications at the rate of 4-5 lbs. per acre are made, but at 10 lbs. per acre, harmful effects become evident. Since the substituted ureas are known to be highly toxic to most species of plants and also very persistent in the soil, some experimental work was desirable in order to determine whether these herbicides could be used with safety in sugar cane under conditions prevailing in Mauritius. Consequently, two experiments were carried out at Union Park and Réduit Experimental Stations, two localties differing in soil type and climate as shown in table 19 below.

Table 19. Soil type and rainfall.

Locality	Soil group	Soil type	Mean annual rainfall in inches
Réduit	Humic latosol	Richelieu bouldery clay	63.5
Union Park	Lithosol	Rose Belle gravelly clay	143.0

Method: The two substituted ureas:

(a) CMU: 3 — (p-chlorophenyl) — 1, 1— dimethyl urea

(b) PDU: 3 — phenyl — 1, 1 — dimethyl urea

were applied at the rates of 2, 4, 6 and 8 lbs. in 60 gallons of water per arpent. Plot size was 1/200 arpent and the treatments were randomised with fourfold replications. CMU and PDU were applied in both pre and post emergence of the canes (variety M. 134/32) but before weed emergence. In the pre-emergence trials application was made a few days after planting and in the post-emergence trial on canes about 6 weeks old. Observations were made at weekly intervals and weed assessment by the frequency abundance method was done 10 weeks after spraying.

Results and Conclusions: The data obtained are presented in tables 20 and 21 from which it appears that the substituted ureas have apparently been more effective at Union Park than at Réduit. Typical treated and control plots of the 2 lb. treatment at Union Park are illustrated in fig. 25. It must be pointed out, however, that the dry conditions prevailing at

Table 20. Réduit — Pre-emergence weed trial

Treatment lbs/arpent	Weed infestation in % control 10 weeks after spraying	
	CMU	PDU
2	73	50
4	60	42
6	40	53
8	43	53

Table 21. Union Park Pre-emergence weed trials.

Treatment lbs/arpent	Weed infestation in % control 10 weeks after spraying			
	Before germination of cane setts		6 weeks after germination of cane setts	
	CMU	PDU	CMU	PDU
2	26	31	17	29
4	23	27	19	21
6	17	12	17	17
8	9	15	13	13

Réduit during the course of this experiment have probably affected the efficacy of the herbicides. Although, there are indications that CMU is slightly more effective than PDU in the Union Park trial it is not possible at this stage to assess the relative merits of the two herbicides. It should be noted, however, that no adverse effect on cane growth has so far been observed, but owing to the persistent nature of these herbicides in the soil it would be premature, at present, to draw any conclusions.

To sum up, it must be stressed that although the substituted ureas appear promising for the pre-emergence control of weeds in sugarcane yet it must not be overlooked that these chemicals are highly phytotoxic and persistent herbicides. It would not therefore be sound agricultural practice to use these herbicides on a field scale until more is known about their effectiveness under conditions prevailing in Mauritius.

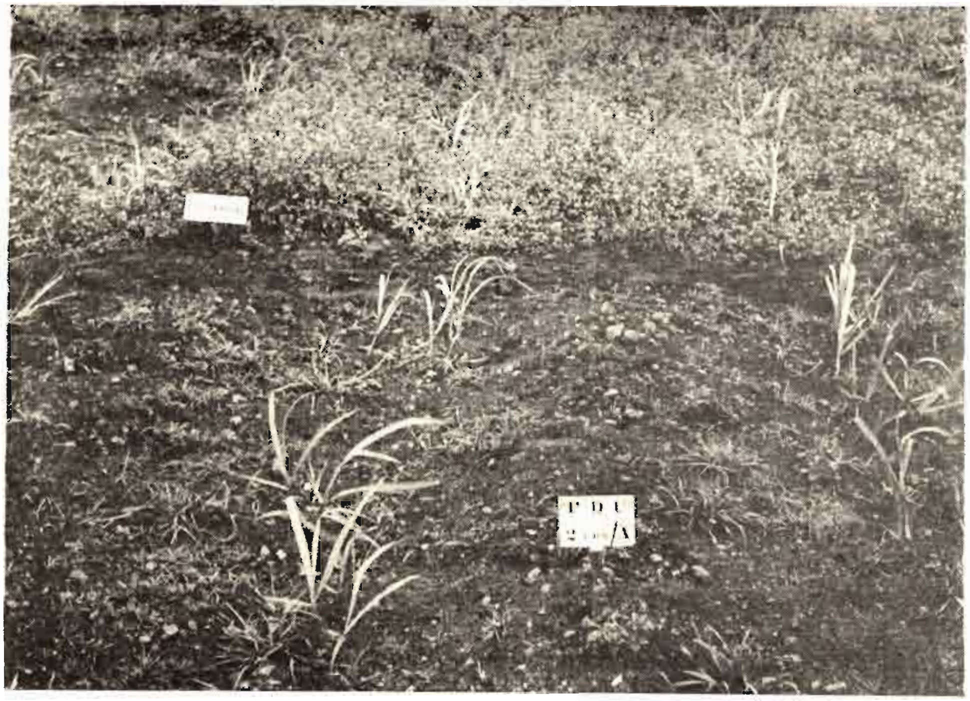

Fig. 25. Effect of PDU applied at 2 lbs. per arpent in pre-emergence of canes and weeds. Photograph taken 8 weeks after spraying.

4. EXPERIMENTS ON CHEMICAL WEEDING OF NUTGRASS

Nutgrass (*Cyperus rotundus*) is known in Mauritius as " herbe à oignons ". It is a troublesome weed in sugarcane fields owing to its rapid and effective method of propagation by means of an extensive system of rhizome and tubers. This weed occurs throughout the island but attains its full development in the humid zone where it is found frequently in local societies with other species such as *Argemone mexicana* (" chardon "), *Solanum nigrum* (" brède martin "), *Bidens pilosa* (" villebague "), *Siegesbeckia orientalis* (" herbe de Flacq ") and other annuals. Distribution of tubers in the soil, in heavily infested areas, has been found to vary with soil type and rainfall, the greatest number of tubers being found in the 6″ depth (fig. 26). Chemical analyses of the leaves and tubers for nitrogen, phosphorus and potassium has shown that nutgrass can export fairly large quantities of fertilizers from the soil (fig. 27).

Eradication of nutgrass by forking and removal of tubers by hand has given satisfactory results only in the case of small areas. When the weed has been thoroughly established this method of control is impracticable. Investigations carried out on the weed with a number of selective and non selective herbicides are summarised below from an article submitted to the IXth Congress, International Society of Sugarcane Technologists.

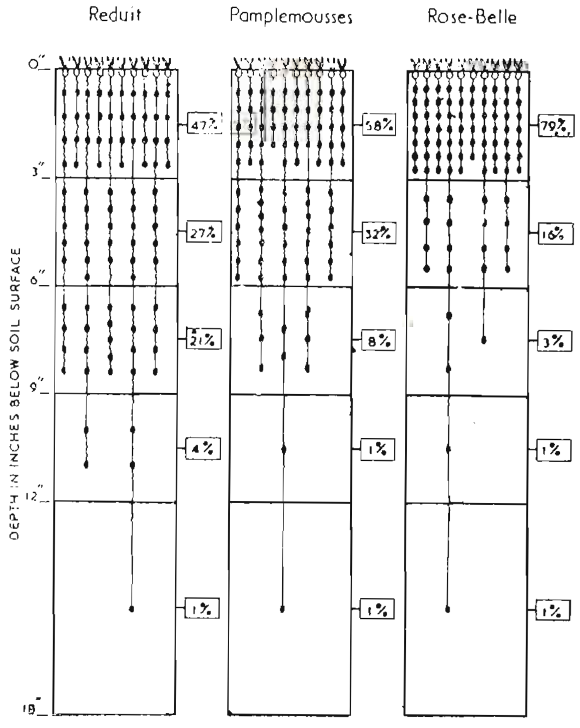

Fig. 26. Distribution of rhizomes and tubers of *Cyperus rotundus* at different soil depths in cane fields of three localities of the island.

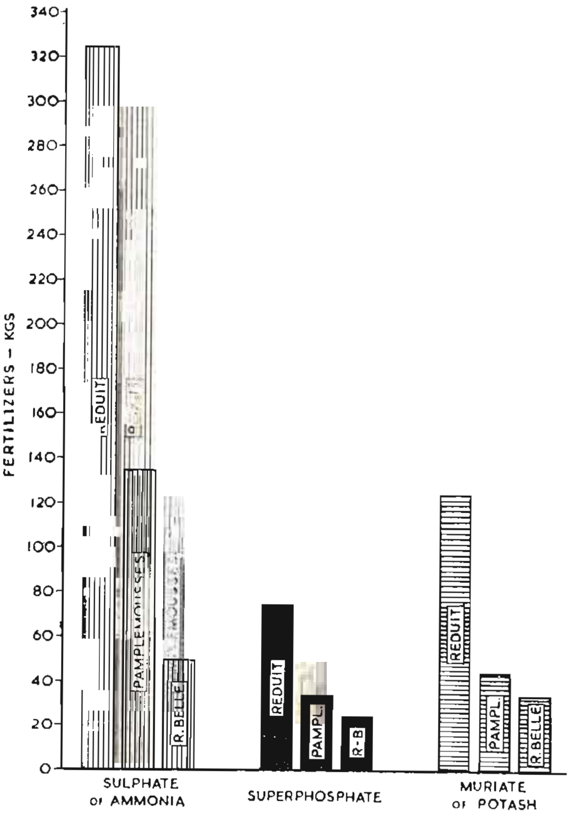

Fig. 27. Amount of NKP held up by *Cyperus rotundus*, in terms of common fertilizers per arpent, in cane fields of three localities of the island.

Experimental work

A series of experiments were carried out in the humid localities of the island in pre- and post-emergence of the weed. Pre-emergence plots and control plots were hoed to a depth of about 3 inches and the tubers removed by hand. Density of aerial shoots was established by the quadrat method and assessment of mortality scored according to the degree of damage sustained by the plant. Gallonnage was kept throughout the trial at the standard rate of 100 gallons per arpent.

In the first experiment the following weed killers were used.

Ammonium sulphamate at the rate of 50 and 100 lbs per acre
T. C. A. ,, ,, ,, ,, ,,
2, 4D, Triethanolamine ,, ,, 4 lbs acid equivalent per acre
2, 4D, isoprophyl ester ,, ,, 2 ,, ,, ,,

Scoring for new growth was made six weeks after treatment and that for mortality six weeks and three months after treatment.

All treatments gave very poor results in pre-emergence spray. In post-emergence ammonium sulphamate and TCA at the above doses were ineffective, whereas amine and ester derivatives gave satisfactory results, killing a larger proportion of basal bulbs.

In the second experiment chemically different esters and amines of 2, 4-D were compared in post-emergence of the weed. Three sprayings were done at three monthly intervals. Observations were made over a total period of nine months and the density of aerial shoots scored immediately preceding each spraying.

Nine months after the first spraying the density of nutgrass in the different treatments were recorded (table 22.)

From the results obtained it is apparent that amine salts gave a better control of nutgrass than esters, dimethylamine standing out as the best treatment.

In the third experiment, CMU was applied at doses varying from 2 to 16 lbs per arpent in alternate rows of virgin canes about 2 months old. The chemical was applied in pre and post-emergence of the weed. Scoring for mortality was made three months after treatment and effects of the herbicide on cane growth was observed at the same time. At the doses used CMU did not give satisfactory control of nutgrass in both pre and post-emergence spray. Cane growth was checked at the higher doses of the herbicide and this was associated with a partial chlorosis of the leaves.

The results obtained indicate that complete eradication of nutgrass cannot be obtained with the chemicals employed, but that fairly satisfactory control may be achieved by repeated applications of amine and esters of 2, 4 D.

Table 22. Effect of 2, 4-D on nutgrass.

Treatments (lbs per acre)	No. of shoots in % control 9 months after 1st spraying.
AMINE SALTS	
Methanolamine — 4 lbs ac. eq./ap.	60.9
Dimethylamine — ,, ,,	55.2
Di-ethanol methyl amine ,, ,,	57.2
ESTERS	
Ethyl ester — 1 lb ac. eq./ap.	68.1
Isopropyl ester — 2 lbs. ,,	65.7
Butyl ester — ,, ,,	66.4
Butoxy ethanol ester — ,, ,,	63.0

CULTIVATION EXPERIMENTS

GUY ROUILLARD

1. EARTHING-UP

THE practice of earthing up cane stools after harvest is still carried out in certain localities of Mauritius. It consists in bringing soil of the interline on the cane row after fertilizers have been applied. The commonly accepted view is that the development of roots from shoots arising from stumps is thus favoured, but it is doubtful if such shoots can produce millable canes, particularly in the case of vigorous varieties now in cultivation, in which numerous shoots arise from below ground level.

The Sugarcane Research Station conducted 5 experiments in 1938 on the free soils of humid localities to study the effect of earthing-up. The varieties planted were White Tanna and B. H. 10/12 and the experiments were followed for 2 consecutive year. Earthed-up plots yielded 1.60 tons more than the control. In 1947 a series of 24 experiments was planned in the humid, sub-humid and irrigated North of the island ; 8 were laid down every year for 3 consecutive years and were followed during 5 years. Another series of 6 experiments was conducted in the super-humid zone from 1951 to 1953. Each trial consisted of 24 plots (6 rows x 50′ long) with 12 replications for each treatment. In addition to the yield of cane and sugar, the number of millable stalks in each plot was counted yearly and leaf samples were also collected for foliar diagnosis and vegetative index determinations. The results obtained in these experiments are summarised in table 23. They are based on a comparison of 1092 pairs of treatments.

Table 23. Summarised results of 24 trials in the sub-humid and humid zones carried out during 5 consecutive years to study the effect of earthing-up.

	Control	Earthing-up
Number of millable stalks per arpent (1)	22,450	22,880
Tons cane per arpent (2)	31.95	33.00
C.C.S.% cane	10.94	10.96
Tons C.C.S. per arpent	3.50	3.62
Vegetative Index	100	99.8
Foliar Diagnosis : N	1.46	1.47
P_2O_5	0.55	0.56
K_2O	1.54	1.59

(1) Sig. diff. (P = 0.05) = 423
(2) Sig. diff. (P = 0.05) = 0.52

The conclusion which may be drawn from these results is that earthing up has caused a small but significant increase in weight of cane, probably because of better stooling, as revealed by the number of millable stalks which is 1.9% higher than in the control plots. The operation has had no effect on sucrose contant or uptake of major nutrients.

With a view to assess the effect which earthing-up may have in different climatic zones or under different soil conditions, available data on cane weight have been grouped according to location of the trials. The results are shown in table 24.

Although statistically not significant, these data reveal that earthing-up may have a beneficial effect on yield under conditions of high soil humidity such as prevail in the super-humid zone and in irrigated localities.

The effect of earthing-up is more pronounced on free soils than on gravelly soils, probably because the operation cannot be performed as efficiently on the latter soil type on account of its coarseness.

Table 24. ***Effect of earthing-up on cane weight expressed as % of the control in different climatic zones and on different soils type.***

Soil Type \ Climatic Zone	Sub-humid		Humid	Superhumid
	Not irrigated	Irrigated		
Free	102	106	103	108
Gravelly	96	—	101	106

2. CULTIVATION OF INTERLINE

It was a common practice in Mauritius in the past, to fork every alternate cane interline to a depth of 8″ to 10″ some time after harvest and before earthing-up the stools. Five experiments carried out by the Sugarcane Research Station in 1938 and repeated during two years showed that there was no increase in yield.

With the development of mechanical cultivation during the last ten years there is an increasing tendency to cultivate interlines in ratoon fields immediately after harvest. With a view to determine whether this cultural operation is beneficial, a series of 24 experiments was planned in 1947, eight being planted yearly, in the sub-humid and humid regions of the island. The experiments were conducted simultaneously with those concerning earthing up, the same control plot being used in both cases. It was not possible to include trials in the super-humid zone because young suckers are not cut at harvest in these localities and would be damaged by interline cultivation. Each plot consisted of six cane rows 50′ long; cultivation of the interline at a depth of 8″ to 12″ with implements available at each centre, was compared to control plots. In order to eliminate the detrimental effect which the tractor might have on young shoots, the machine travelled at the same speed along the control rows but without the implement attached.

Leaves were sampled yearly for vegetative index and foliar diagnosis, millable stalks were counted and the canes were weighed and analysed at harvest. The experiments were continued until the 5th ratoons, and a summary of the results obtained is given in table 25.

These data show that interline cuitivation has had no effect on vigour of growth, stooling, uptake of nutrients, yield of cane and sugar.

From a practical point of view however it should be pointed out that surface cultivation by mechanical means facilitates earthing-up, improves drainage, helps in checking weed growth, gives a better tilth, which in turn renders weed control by chemicals more efficient.

Table 25. Summarised results of experiments on the effect of interline cultivation.

	Control	Interline Cultivation
No. of millable stalks per arpent	22,430	22,365
Tons cane per arpent	31.95	32.11
C.C.S.% cane	10.94	10.90
Tons C.C.S. per arpent	3.50	3.50
Vegetation index	100	100.4
Foliar Diagnosis : N	1.46	1.51
P_2O_5	0.55	0.54
P_2O	1.54	1.61

3. TIME OF APPLICATION OF NITROGEN

There are widely different views among planters in Mauritius as to the time when Nitrogeneous fertilizers should be applied to growing canes. Some favour split applications, while others prefer to apply the whole amount of fertilizers soon after harvest or later in the season.

It was felt therefore that useful information might be obtained from a series of comprehensive experiments designed to determine the effect of different methods of application of Nitrogen on yield and sucrose content.

Table 26. Results obtained from single and double applications of Nitrogen:

	Humid			Sub-Humid (Irrigated)		
	TC/A	CCS%C	TCCS/A	TC/A	CCS%C	TCCS/A
Control	27.32	12.59	3.44	22.63	12.33	2.79
30 Kgs. N. one application	32.95	12.05	3.97	31.63	11.76	3.72
60 Kgs. N. one application	35.50	11.69	4.15	34.61	11.27	3.90
30 Kgs. N. two applications	32.28	12.05	3.89	30.68	11.70	3.59
60 Kgs. N. two applications	35.50	11.69	4.15	36.13	11.21	4.05

Accordingly, 51 trials were planted in the humid zone and 17 in the sub-humid irrigated localities, in 1949 and kept under observation until 1955. The trials consisted of 5 x 5 latin squares with the following treatments.

1. Control
2. 30 kgs N applied early (August)
3. 60 kgs N " " (")
4. 30 kgs in 2 applications of 15 kgs each: early (August) and late (December)
5. 60 kgs in 2 applications of 30 kgs each: early (August) and late (December)

Weight of cane and C.C.S. determinations were made in virgin and 5 ratoons. The results obtained are summarised in table 26 and fig. 28 from which it may be inferred that there is no significant difference in yield of cane and sncrose between the single and double applications of Nitrogen.

Another series of 13 latin squares was laid down in the sub-humid unirrigated areas in the north of the island. The data obtained from these trials during 1949 to 1955 are given in table 27 and fig. 28; they indicate that Nitro geneous fertilizers may be applied at any time from July to December in the unirrigated areas of the north of the island.

Conclusion: The results obtained from experiments conducted in the humid and sub-humid (irrigated and non-irrigated) zone of the island, show that nitrogeneous fertilizers may be applied in one or two doses, indiscriminately. The average results, though statistically non-significant, are in favour of early applications; it is therefore recommended to apply the normal nitrogen requirement in one operation as soon as feasible after harvesting. In any case, all applications should be completed by the end of the year.

There are some limitations to the above general recommendations: cane planted on slopy lands in super-humid climates could benefit from split applications should there be any menace of nitrogen losses due to leaching,

These results also confirm that normal Nitrogeneous fertilization for conditions prevailing in Mauritius should be of the order of 40 Kgs of Nitrogen par arpent, the beneficial effect of higher doses of Nitrogen being more accentuated in irrigated areas.

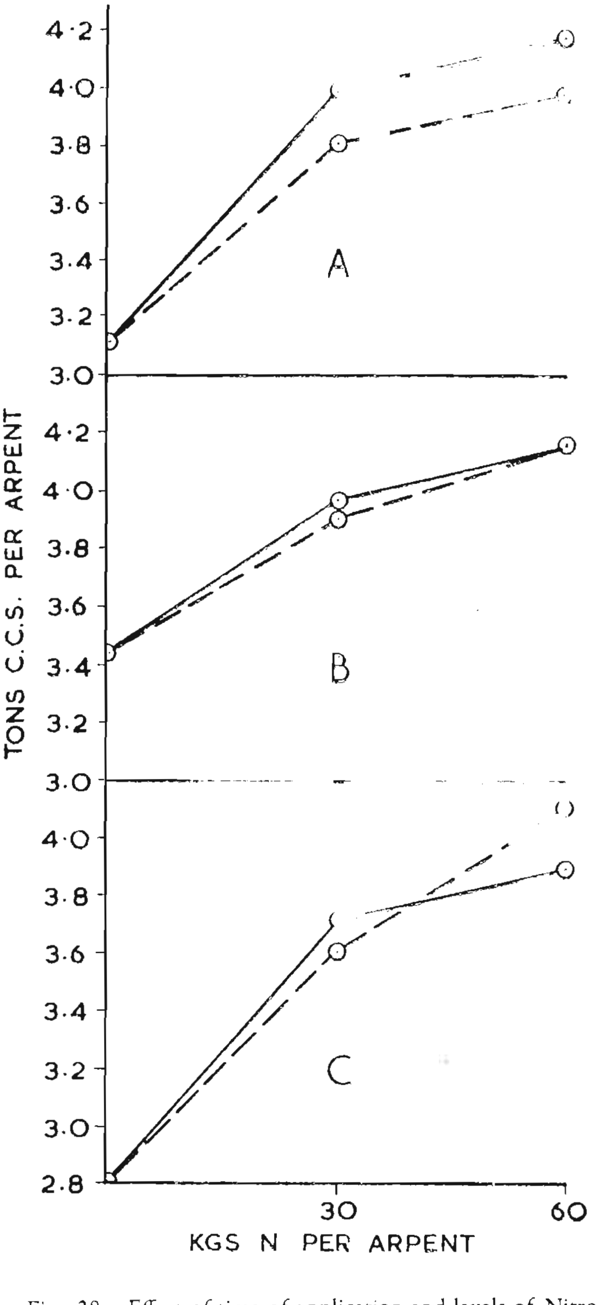

Fig. 28. Effect of time of application and levels of Nitrogen on yield of sugar per arpent in different localities. Plain line: total application, early; broken line: two applications early and late. A. sub-humid zone; B. humid; C, irrigated

Table 27. Comparison between early and late applications of nitrogen in sub-humid unirrigated zone.

	Tons cane per arpent	CCS% cane	Tons CCS per arpent
Control	23.87	13.07	3.12
30 Kgs. N. one early application	30.90	12.88	3.98
,, two early/late applications	30.69	12.38	3.80
,, one late application	29.81	12.68	3.78
60 Kgs. N. one early application	33.33	12.51	4.17
,, two early/late applications	33.42	11.88	3.97
,, one late application	31.79	12.52	3.98

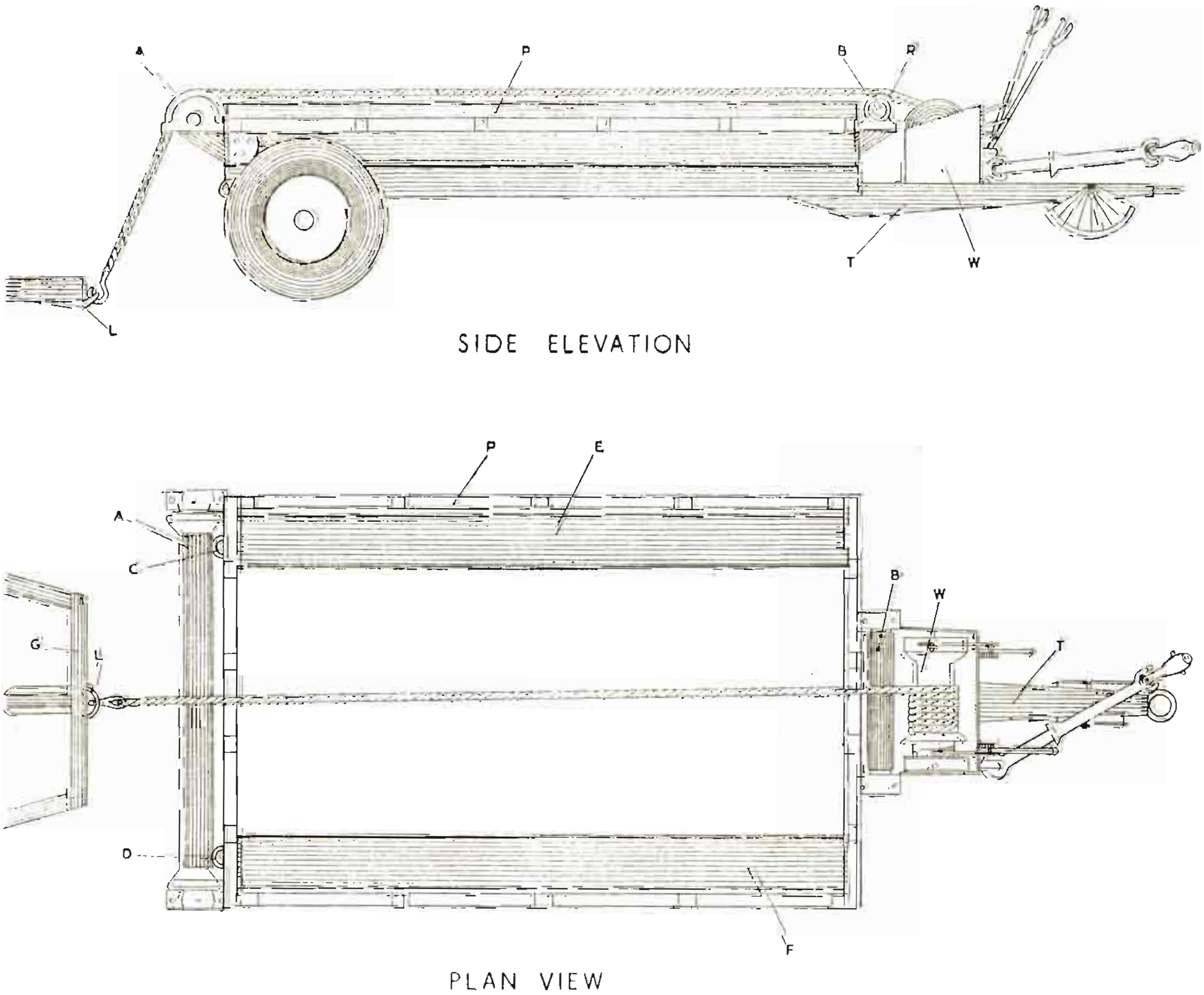

Fig. 29. Plan and elevation of self loading trailer.

SELF LOADING TRAILER

G. MAZERY

DURING the year under review it has been possible to put into operation a self loading trailer which has worked satisfactorily throughout the crop.

This machine, although a prototype, may be considered as a commercial model and a further improvement to the "Massey Harris" self loading trailer.

The new device was installed on a standard "Ferguson" tipper trailer. It is shown in figs. 29-33 and is briefly described below.

1. *Trailer.*

(i) A winch W provided with 30 ft. $\frac{1}{2}''$ steel cable is mounted on the two-bar. T of the trailer, the two-bar being lenghthened about 2 ft. in order not to interfere with the "manoeuvering" of the tractor.

(ii) A flanged steel roller, A 5″ diameter and extending across the whole width of the trailer is mounted at the rear end of the platform P. Another roller B of the same diameter, 2 ft. long, is mounted at the fore end of the platform next to the winch W.

Fig. 30. Loaded crate.

Fig. 31. Crate being lifted on tractor.

(iii) Two loops C and D made of $\frac{3}{4}''$ round iron are welded to the rear end of the chassis.

(iv) Two steel plates, E and F, $\frac{1}{8}''$ thick by 9″ wide are fixed over the platform, one along each of the long sides in order to serve as slides for the metal crate.

2. *Crate.*

The crate is similar to those used with other types of self loading trucks except that it rests on three iron beams G 4″ U shaped about 11 ft. long, laid about 24″ apart and joined at the fore end. An iron loop L is welded to that end as indicated in fig. 29.

Fig. 32. Loaded crate on trailer being hauled to factory.

3. Operation.

(a) The canes are loaded into the crate which lies on the ground.

(b) The rear end of the trailer is brought near the fore end of the crate as far as possible in line with it.

(c) The free end of the cable W is hooked on to the loop L.

(d) The winch is put into action by means of the power take-off from the tractor. The winding cable first pulls the trailer and tractor backwards. The crate, then raises the fore end of the latter vertically, pulls it over roller A and forwards over the platform of the trailer. When the centre of gravity of the loaded crate has passed beyond roller A, the former gently tips over to the horizontal position, the longitudinal beam G slides over metal plates E, F, until the load has reached its final position.

When travelling over rough surfaces, the load is secured on the platform by passing the cable W over the canes and hooking it to loops C and D.

In practice the standard derrick chains have proved quite sufficient for keeping the canes in position on the crate during the loading operation. It has been possible when necessary, to unload the crate with the canes without difficulty or damage by tipping, excessive shock being avoided by the use of the winch's hand brake.

This machine has been used successfully for handling the cane crop of the experimental station at Réduit during the 1955 harvest, the trailer carrying regularly a 3 ton load.

In this particular case the standard platform has been left on the trailer in order to be able to carry any material. If the machine were devoted exclusively to the transport of canes, an additional roller mounted across the central portion of the chassis could replace the platform.

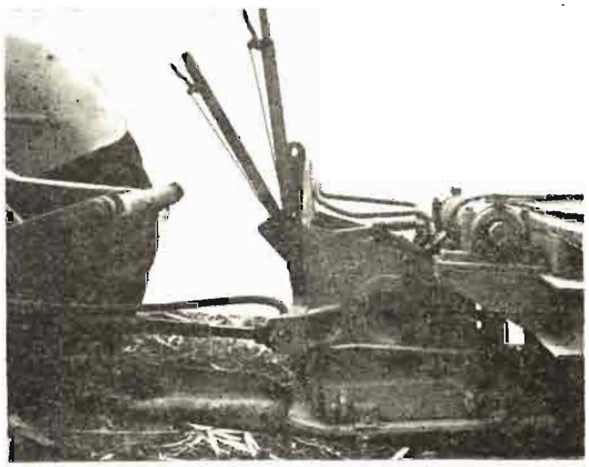

Fig. 33. Details of winch and controls.

CANE ANALYSIS

PIERRE HALAIS

INTRODUCTION

ANALYSIS of harvested cane stalks for quality determination occupies a central position in sugarcane research, payment, and factory control. But the analyst is up against many pitfalls which must be tackled if accurate results are to be obtained.

There are numerous and diverse sources of error which are difficult to overcome in order to secure representative sampling; the following being the most important:

(1) variability from field to field over the same sugar estate;

(2) from site to site over the same field;

(3) from stool to stool over the same site;

(4) from stalk to stalk on the same stool;

(5) from butt, middle and top sections on the same stalk;

(6) between and within nodes or internodes on the same section;

(7) lack of precision in topping height;

(8) frequent inclusion of free or adhering tops, trash, side shoots, roots, dead canes, soil, etc., with the cane crop which are weighed in the field during agronomic investigations or with the canes as delivered at the factory weighbridge and which finally enter the mill;

(9) working out a net weight of clean cane stalk is a delusive correction as the extraneous matter is not simply passive: whilst it brings impurities, it carries away juice with the final bagasse during milling operations.

Another major difficulty is the normally high fibre content — 8 to 15% — of the cane stalk and extraneous matter. The hard lignified cells are the chief obstacle to complete extraction of soluble constituents, including sucrose, by means of simple analytical procedures.

All those reasons have probably contributed to prevent or retard the devising of a general direct laboratory method for cane quality determination and chemists have had to rely on various indirect schemes.

Agricultural chemists, therefore, have had to be satisfied with comparative quality testing usually carried out by means of small laboratory equipment: Cuban mills, "fibrators" etc., requesting the frequent inclusion of a standard variety or treatment capable of disclosing significant differences in spite of unavoidable weaknesses in the actual values obtained for Brix, sucrose and fibre % cane. Furthermore, the large experimental error attributed to cane sampling, preparation and extraction, carried out under those conditions, calls for laborious replications before valid conclusions can be reached.

Factory chemists, on the other hand, are in need of more absolute figures and they have had to rely on basic data collected outside their laboratory. Concerning cane payment, for instance, they are using the analysis of the first expressed juice, collected from the first mill of the factory, in conjunction with fibre determination made on small clean cane samples subjected to disintegration by means of a 'fibrator' as practised in Queensland since some forty years. Empirical factors are made use of to arrive at Brix, sucrose, and fibre % cane as this raw material is delivered at the weighbridge.

The necessary data for running the balance sheet of sucrose for factory chemical control, usually starts with the weighing of the whole mixed juice entering the boiling house. The calculation of the weight of final bagasse is obtained by difference between the total weight of canes milled and the combined weights of mixed juice and imbibition water, neglecting losses by evaporation etc.

It is thus clear that there is real need for much improvement in the present analytical procedures of cane quality determination and nothing less than the devising and working out of an accurate and independant laboratory method on radically new principles will bring generalized adoption by the Sugar Industry.

Consequently the M.S.I.R.I., since its inception, has decided to acquire the modern equipment needed for carrying out this useful line of investigation, encouraged by the new possibilities arising from the latest developments in chipping, shredding and high-speed blending.

DEVELOPMENT OF AN ACCURATE LABORATORY METHOD

A. Cane Sampling. The collecting of fully representative cane samples, *free from bias*, is a pre-requisite to any accurate quality testing.

For agronomic investigations, including comparative variety testing, fertilizer treatments etc., relatively small cane samples from each individual plot constituting the field trial may give satisfactory information provided that certain precautions are taken. One of the great difficulties commonly met with is the sectioning of the cane stalks into two or more unequal portions during manual harvesting. It follows that under such conditions larger weights of cane have to be sampled in order to reach comparable accuracy with the same harvested crop made up of whole cane stalks.

Two steps may be taken, according to practical conveniences: (1) either the sampling is made prior to harvesting or (2) the cane cutters are instructed not to section the harvested cane stalks at all when harvesting experimental plots. The general rule recommended by the Institute is to select from each plot (about 0.05 acre in size) a total of 30 whole cane stalks at six well-spread sites over its effective area by taking at each site: (1) five immediately contiguous stalks on a random-selected stool or (2) one hand-grab bundle of five cane stalks in case the crop has been already harvested following the special instructions mentioned above. If pre-harvest sampling is adhered to, care should be taken to top the selected canes at the usual height. If convenient for transport, the cane stalks may be sectioned after sampling.

Fully representative cane samples for factory chemical control have to be much larger in size in order to cope successfully with the heterogeneous mass of sectioned stalks and extraneous matter which constitute the raw material delivered at the factory and entering the mill as such.

Two schemes seem possible: (1) grab sampling of large bundles taken at regular intervals from the cane carrier of the mill or (2) smaller bulk sampling of the material already prepared by the factory cane knives — or shredder — before being fed to the first mill. In view of the rapid fermentation of disintegrated cane samples, it is felt that bundle sampling on the cane carrier is a more flexible and desirable proposition.

As a general rule, minimum delay should be allowed between sampling and analysis.

B. Cane Chipping. The idea in carrying out this step is to reduce the *entire cane sample* into 1 inch chips without loss of juice, in order to allow for later sub-sampling prior to further shredding.

A locally designed and constructed small size cane-cutter (fig. 34) provided with revolving knives and powered by a 10 h.p. electric motor has been tested at the M.S.I.R.I. for this purpose. It has given moderately satisfactory results when dealing with the standard 30 cane stalks samples taken for agronomic investigations.

A more efficient and powerful (25 h. p.) Mc Cormick model 9, ensilage-cutter has been proposed lately by the Hawaiian Sugar Planters' Association Experiment Station (Special Release No. 128, Sept. 1955). This equipment which is provided with a blower and a sampling chute is capable of dealing rapidly with grab cane samples amounting to some 200 kg. A similar type of ensilage-cutter will be required for proper chipping of the large cane samples taken for factory control.

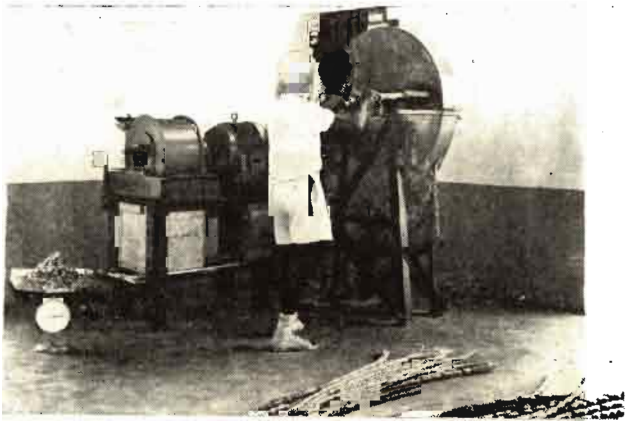

Fig. 34. Cane-cutter and Waddell shredder used for preliminary disintegration of cane sample.

C. Cane Shredding. As could be expected, one kg. of chipped cane cannot constitute the ideal sub-sample for final blending in view of complete sucrose extraction. Preliminary shredding is necessary *to homogenize* as much as possible the cane sample and to reduce the strain put on the high speed blendors now on the market.

The laboratory shredder (fig 34) tried and adopted at the M.S.I.R.I. is the 10 h.p., 1500 r.p.m., hammer mill described by Waddell (Proc. Eight Congress I.S.S.C.T. p. 828, 1953). It is capable of shredding up to 5 kg. portions of chipped canes in about 30 seconds without loss of juice and seems well suited for carrying out this necessary intermediate step in the progressive disintegration of cane samples prior to analysis.

A one kg. sub-sample is carefully taken out of some 10 kg. of shredded cane and cold-stored to prevent fermentation losses if final blending is to be carried out later on composite samples either from homologous plots as is common with agronomic investigation, or from hourly sub-samples as is the practice for sugar factory chemical control. The Waddle shredder has also been found to be very useful for making the composite samples in approximately 10 seconds.

D. Cane Blending. The principle made use of in modern blending is the *complete extraction* by cold water of the soluble constituents, including sucrose, of the cane by means of high speed electrical devices reaching 16,000 r.p.m. It stands to reason that if sucrose (Pol) extraction is proved to be complete, that of other soluble constituents (Brix) is also complete, thus facilitating the final washing for correct fibre determination to be made on the same blended cane aqueous mixture.

Special equipement for final water extraction has been designed by the H.S.P.A. (Special Release No. 128 Sept., 1955) for 1 kg. cane chip samples and by the Queensland Sugar Research Institute (Foster D. H., Tech. Rep. No. 24, 1954) for 1 or 2 kg. of canes as fed to the first mill.

The recent advent on the market of a giant model (Model CB-2) of $5\frac{1}{2}$ litres capacity, of the well known Waring Blendor, (fig. 35) equipped with a 2 h.p. motor and running at four speeds ranging from 8,000 to 16,000 r.p.m. offers excellent opportunity for adoption in cane analysis. This new blendor has been available to the M.S.I.R.I. only at the close of the 1955 sugar campaign, but the tests carrried out have already given proof of its special usefulness. This "Giant Waring Blendor'' has also been lately recommended by the H.S.P.A. in addition to their special disintegrator.

It had to be proved in the first place that rapid direct blending of 1 kg. of shredded cane with 3 kg. of liquid, extracts the sucrose completely. A series of comparative tests was started at the M.S.I.R.I. in order to solve this fundamental problem and samples from the same shredded cane portion were taken: (a) one kg. for the direct sucrose extraction by means of the Giant Waring Blendor and (b) one kg. for similar blending after more perfect preliminary disintegration than shredding had been carried out by means of a Model 2 Wiley laboratory mill (fig. 35) so that the whole bagasse separated from the juice following the use of a powerful press should be made to go through the 2 mm. sieve of the Wiley mill. All the pressed out juice, washings from the press, sieved bagasse, 1 gm. sodium carbonate, and a few drops of alcoholic mercuric chloride preservative, were placed in the container of the blender and the total weight of the mixture brought to exactly 4 kg. with the addition of water as was the case for the direct blending described above.

Table 28 published below, shows the results obtained on ten pairs of comparative tests: (1) five made on the same shredded portion of M. 134/32 canes, a variety with low fibre content and (2) five on the same shredded portion of B. 3337, a high fibre variety. As the ultimate aim is comparison of sucrose extraction by means of two blending procedures to be proved through the use of a precise Schmidt and Haensch saccharimeter on the same shredded cane portion for each variety, the individual calculations were made by allowing a fixed 10% fibre content for

Fig. 35. Cane analysis equipment showing from left, Wiley mill, Waring blendor, fibrator, hydraulic press and saw.

M. 134/32 and 12% for B. 3337, so as to eliminate an indirect cause of variation.

It is thus definitely proved that direct blending gives correct sucrose (Pol) extraction in a short time, irrespective of the fibre content of the cane variety.

Of course, the strain put on the Blendor was reduced to negligible proportion when the size of the separated bagasse was previously reduced to less than 2 mm. by means of the Wiley mill. The use of the latter offers additional advantagcs for sugar factory control as it has already been recommended (Shivas and

Table 28. Comparative pol % cane using a Waring blendor and a Wiley mill.

Variety	Giant Waring Blendor	Wiley mill and Giant Waring Blendor
	Pol % Cane	Pol % Cane
M. 134/32	15.92	15.96
,,	15.96	15.96
,,	15.92	15.92
,,	15.89	15.96
,,	15.89	15.96
B. 3337	14.36	14.48
,,	14.48	14.52
,,	14.56	14.44
,,	14.28	14.55
,,	14.36	14.43
Averages	*15.17*	*15.22*
L.S.D (P=0.05)		± 0.06

Bringhurst, Sugar, p. 48, April 1955) for improving rapid sucrose — and fibre — determinations in the routine analysis of final bagassse. It should be mentioned, in this connection, that the best estimation of weight of final bagasse can be derived from accurate fibre % cane and accurate fibre % final bagasse data, provided *both* are available.

Furthermore, the high reproductibility — less than 1 % coefficient of variability — speaks much for the accuracy achieved in adopting the combination Waddell shredder and Waring Blendor.

The actual procedure is briefly described below: 1,000 gm. is carefully weighed out from the larger 10 kg. sample of shredded cane. It is placed in the blending vessel with a few drops of alcoholic mercuric preservative, 10 cc. of 10% sodium carbonate to prevent inversion, and enough water to make a final weight of 4 kg. The whole mixture is progressively blended at low, medium and high speeds during a total time of 7 minutes, approximately.

The blended mass is sieved and separated into diluted juice and fibre. After allowing to cool, the Brix is determined by means of an accurate refractometer (Zeiss Abbe), five readings are taken carefully and temperature corrections made. The Pol of the juice is determined aften clarification with dry Horne's lead acetate, using the 400 mm. pol-tube and taking three readings or a standard saccharimeter. After applying the appropriate temperature correction, the Pol of the juice is read from a table.

The fibre content is found after thorough washing on a 100 mesh sieve fitting the interior of a larger Buchner funnel carrying suction (H.S.P.A. Special Release No. 128, 1955). The dessication of the whole fibre collected is finally achieved in a few hours inside a forced draught electric oven maintained at 120-130°C.

It is felt that a short cut in fibre determination could eliminate time consuming washing on the sieve when the Brix of the diluted juice in the blended mixture is already known. Following the blending, excess of diluted juice is rapidly separated from the fibre by hand squeezing inside a piece of tared and dry, fine cloth held over a large Buchner funnel to keep the finest particles. Weight of total wet fibre and cloth is rapidly taken before being placed for drying inside an electric oven, at the conclusion of which the dry weight is also taken. The difference in weight represents the moisture contained in the wet fibre which allows for the calculation of the associated Brix to be substracted in order to find out the net weight of dry insoluble matter defined as cane fibre.

Example of Calculation:

Weight of shredded cane	1000 gm.
,, ,, added liquid	3000 gm.
,, ,, Sodium Carbonate	1 gm.
,, ,, dry fibre	124.8 gm.
,, ,, absolute juice	1000 — 124.8 = 875·2 gm.
,, ,, diluted juice (d. j.)	3000 + 875.2 = 3875.2 gm.
Brix % gm. d. j.	4.51
Pol % gm. d. j.	4.22
Brix % Cane	$\frac{4.51 \times 3875.2}{1000} = 17.48 - 0.10 = 17.38$
Pol % Cane	$\frac{4.22 \times 3875.2}{1000} = 16.35$
Fibre % Cane	$\frac{124.8 \times 100}{1000} = 12.48$

E. ***Conclusion.*** The broad principles of an accurate direct laboratory method of cane quality determination have been laid down for both agronomic research and factory control. It is carried out by means of progressive disintegration through chipping and shredding prior to final blending. But more details will have to be worked out to suit practical considerations such as preservation of one kg. sub-samples of shredded canes by freezing or otherwise, for preparing composite samples.

The entire representative cane sample of appropriate weight has to be chipped by means of revolving knives or of an adequate ensilage-cutter to 1 inch. chips. About 10 kg. or cane chips are shredded into a hammer mill of the Waddell type. One kg. of the shredded cane mixed with 3 kg. of liquid is blended for a few minutes in a " Giant Waring Blendor." Refractometric Brix and sucrose (Pol) of the diluted juice extracted are taken by means of standard instruments. Fibre is carefully washed by suction on a fine sieve placed inside a larger Buchner funnel. Dessication is carried out as usual inside a well ventilated electric oven. A short cut, eliminating time-consuming washing of the fibre on the sieve, is also available.

The Wiley mill has already been recommended for accurate sucrose aud fibre determinations in final bagasse, it can find additional use for achieving further disintegration prior to the blending of the few composite samples to be analysed daily at the sugar factory laboratory. Under such conditions very little strain is placed on the blendor which works more smoothly and will probably last longer.

OTHER INVESTIGATIONS

These studies mainly refer to improvements of existing routine methods of cane analysis suited to general agronomy. Instead of the combination, cane-cutter or ensilage-cutter and Waddell shredder now recommended for the initial preparation of entire cane samples, two other devices were available for dealing with clean canes:

(a) the *fibrator*, as used for fibre determination in Queensland, Mauritius and elsewhere (fig. 35). This type of grater has found regular use for disintegrating clean cane samples prior to quality determination at the former Sugar Cane Research Station for more than ten years and has been chosen for the same purpose in 1954 and 1955 by the M.S.I.R.I. The main disadvantages of the fibrator are: (1) it can only deal with clean and well topped canes, (2) only comparatively small cane samples can be fibrated and the standard 30 whole cane stalks samples have to be reduced to one third by taking alternate butt, middle and top portions, a procedure which adds to the experimental error, (3) the revolving edges need frequent sharpening in order to obtain an homogeneous mass of cane free from long fibres which prevent good subsampling and preclude the use of the " Giant Blendor " through the entangling of high speed stirrers, (4) manual feeding of the fibrator is tedious and asks for a strong and regular twisting action on the cane stalk, (5) important portions of cane have to be discarded.

(b) The *saw* produces cane dust of excellent physical characteristic for direct high speed blending. The one available at the M.S.I.R.I. (fig. 35) for longitudinal sawing has been built according to the description given by H. Evans of British Guiana who has recently advocated its use in cane analysis for maturity testing (Trop. Agric. p. 134, 1954).

Comparisons of the three methods of initial disintegration:

A. Combined cane-cutter and Waddell shredder,

B. Queensland fibrator,

C. Evans' saw,

have been run systematically on similar cane samples at the Institute before being analysed by the same final procedure making use of a Mohr hydraulic press (fig. 35) used at 100 kg/cm^2 for expressing the juice taken as absolute juice in the calculations. The fibre % cane was determined in all cases by the hot extraction method official in Queensland (Lab. Manual Queensland Sugar Mills. p. 104, 1954.) The results obtained are given in table 29.

It is thus proved that when dealing with comparable clean cane samples, Method A and B give concordant results for CCS, fibre and moisture determinations as required for agronomic investigations. The correlation cœfficient between fibre contents by Waddell and fibrator methods reaching the high figure of + 0.987. On the other hand, longitudinal sawing does not produce saw dust correctly representing the cane stalks, being specially at fault with high fibre varieties.

A similar finding has been published by agricultural research workers of Central Aguirre, Porto Rico (Serbia and Fragoso, Sugar p. 39, May 1955.) who claim accurate results from the use of twin saws taking transverse 1 inch sections of cane at numerous regular 6 inch intervals on the stalks.

Table 29. Each figure is the mean of 18 determinations carried out on a series of clean cane samples.

Method of initial disintegration	M.134/32 canes			B.3337 canes		
	CCS	Fibre % cane	Moisture % cane	CCS	Fibre % cane	Moisture % cane
A. Cane-Cutter plus Waddell shredder	16.88	10.0	71.7	14 55	12.9	69.4
B. Queensland fibrator	16.95	9.6	72.0	14.69	12.5	69.6
C. Evans' saw	17.31	7.1	73.3	15.73	9.7	71.6

DIRECT VERSUS INDIRECT FIBRE DETERMINATIONS

Direct fibre determination by the official Queensland method mentioned above is rather time consuming and the indirect method has always been followed at the former S.R.S. and at the new M.S.I.R.I. in routine cane quality testing.

The indirect method makes use of the simple function, moisture % cane divided by moisture % absolute juice. This last information is derived from the refractometric brix of the juice expressed by means of a Mohr's hydraulic press used at 100 kg/cm^2, on fibrated, shredded or saw dust cane material. Moisture % cane was determined on 200 gm. sub-samples after complete dessication at 100°C. inside a large forced draught electric oven.

The comparison has been worked out on 36 pairs of cane samples and the regression equation obtained is :

Direct fibre % cane = Indirect fibre % cane + 1.3.

The regression coefficient is 1 and the correlation coefficient equals + 0.964.

In the future, for cane analysis pertaining to routine agronomic investigations it is proposed to bring the indirect fibre determinations to the true direct ones by adding 1.3.

APPENDIX *

I. Description of cane sectors

II. Area under sugarcane

III. Sugar production

IV. Yield of cane

V. Sugar manufactured % cane

VI. Sugar manufactured per arpent

VII. Evolution of 1955 sugar crop

VIII. Evolution of cane quality

IX. Rainfall excesses and deficits

X. Wind velocity

XI. Molasses production

XII. Variety trend 1930-1954

XIII. Composition of 1955 plantations

XIV. Relative production of virgin and ratoon canes

XV. Yield of virgin and ratoon canes

XVI. List of crosses made in 1955

* *Grateful acknowledgement is made to the Secretrary, Mauritius Chamber of Agriculture, for providing the necessary data to compile tables II to VI.*

Table I. General description of sugarcane sectors of Mauritius.

SECTORS	WEST	NORTH	EAST	SOUTH	CENTRE
DISTRICT	Black River	Pamplemousses & Rivière du Rempart	Flacq	Grand Port & Savanne	Plaines Wilhems & Moka
ORIENTATION	Leeward	—	Windward	Windward	—
PHYSIOGRAPHY	Lowlands and Slopes	Lowlands	Slopes	Slopes	Plateau
GEOLOGY	Late Lava — Pleistocene.				
PETROLOGY	Compact or vesicular doleritic basalts and subordinate tuffs				
ALTITUDE	Sea level — 900 ft.	Sea level — 600 ft.	Sea level — 1,200 ft.	Sea level — 1,200 ft.	900 — 1,800 feet
HUMIDITY PROVINCE	Sub-humid	Sub-humid to humid	Humid to super-humid		
ANNUAL RAINFALL, Inches. Range and Mean	(30 — 60) 44	(40 — 75) 55	(60 — 125) 94	(60 — 150) 90	(60 — 150) 90
MONTHS RECEIVING LESS THAN TWO INCHES RAIN	June to October	September and October	None		
AVERAGE TEMPERATURE °C JAN.	27.0°	26.5°	25.5°	25.0°	23.5°
JUL.	21.0°	20.5°	19.5°	19.0°	17.5°
CYCLONIC WINDS, greater than 30 m.p h. during 1 hour.	December to May				
PEDOLOGY Soil Groups: (*) A. Low Humic Latosol	" Richelieu " bouldery clay		—		
B. Humic Latosol	—	" Réduit " bouldery clay			
		—	" Sans Souci " bouldery clay		
C. Lithosol	" Mapou " Stony and gravelly clay		—		
(*) Other unclassified groups occur chiefly in the West & North	—	" Plaisance " stony and gravelly clay			
		—	" Rose Belle " stony and gravelly clay		
IRRIGATION	Common	Some	Rare		
APPROXIMATE AREA (in 1000 arpents) SECTOR	56	91	72	160	63
CANE	9	48	38	54	22
SUGAR FACTORIES (Production in 1000 metric tons. in brackets, average 1953 - 55	Médine (30)	Mon Loisir (28) St. Antoine (25) Solitude (21) The Mount (19) Beau Plan (19) Labourdonnais (18) Belle Vue (14)	Union Flacq (54) Beau Champ (27) Constance (21)	Savannah (27) Mon Trésor (24) Union (19) Britannia (17) Rose Belle (14) Bénares (13) Riche en Eau (12) Bel Ombre (11) St. Félix (10) Ferney (9) Beau Vallon (9)	Mon Désert (30) Highlands (18) Réunion (11) Trianon (10)

Table II. Area under sugar cane in thousand arpents[1], 1951—1955. 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
1951	169.11	159.64	7.75	44.61	34.99	51.02	21.28
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 (2)	177.25	167.18	8.82	47.93	36.87	52.22	21.34

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] 1951—1955.

Crop Year	No. of factories operating	Av. Pol	Island	West	North	East	South	Centre
1951	27	98.4	484.1	27.07	144.19	96.12	140.71	67.01
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(2)	26	98.6	533.2	31.60	148.30	103.30	173.90	76.10

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 1951 — 1955.

	1951	1952	1953	1954	1955(1)
ISLAND					
Millers	33.1	30.9	32.5	31.0	31.1
Planters	22.0	19.5	23.1	20.4	19.9
Average	27.3	24.8	27.8	25.4	25.3
WEST					
Millers	35.9	31.7	37.1	32.2	34.3
Planters	25.7	25.0	30.0	25.4	24.3
Average	28.4	27.3	32.4	27.7	27.8
NORTH					
Millers	36.2	30.1	34.9	30.9	29.2
Planters	23.9	18.9	26.3	21.4	20.4
Average	28.2	22.6	29.1	24.6	23.4
EAST					
Millers	36.5	33.6	34.1	29.9	31.8
Planters	20.9	19.5	22.2	18.4	17.4
Average	26.2	24.2	26.3	22.6	22.6
SOUTH					
Millers	31.4	30.7	30.9	31.1	31.1
Planters	20.1	19.6	20.5	20.4	20.3
Average	27.5	26.8	27.3	27.5	27.5
CENTRE					
Millers	30.5	29.3	30.9	31.5	32.4
Planters	20.0	18.4	21.2	19.4	18.7
Average	26.1	24.3	26.7	26.2	27.8

NOTE : (1) *Provisional figures*

(2) *to convert in metric tons/acre* x 0.959

,, *long tons/acre* x 0.945

,, *short tons/acre* x 1.056

,, *metric tons/hectare* x 2.370

Table V. Average sugar manufactured % cane 1951 — 1955.

Crop year	Island	West	North	East	South	Centre
1951	11.12	12.29	11.47	10.48	10.66	12.06
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(1)	12.61	12.85	13.22	12.43	12.11	12.83

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, 1951 — 1955.

	Island	West	North	East	South	Centre
1951	3.03	3 49	3.23	2.75	2.76	3.15
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(1)	3.19	3.58	3.10	2.80	3.33	3.57

NOTE : (1) *Provisional figures.*

Table VII. Evolution of 1955 Sugar Crop, production data at various dates.

	Island	West	North	East	South	Centre	Island	West	North	East	South	Centre	Island	West	North	East	South	Centre	Island	West	North	East	South	Centre
	23rd July 1955						*30th July 1955*						*6th August 1955*						*13th August 1955*					
Cane crushed (1000 m. tons)	131	—	5	53	73	—	266	26	28	87	117	8	486	36	73	125	204	48	704	48	136	152	285	83
Sugar manufactured % cane	10.06	—	10.15	10.00	10.06	—	10.28	10.13	10.68	10.04	10.32	10.27	10.50	10.18	11.02	10.24	10.44	10.91	10.69	10.29	10.97	10.53	10.59	11.15
Sugar manufactured (1000 m. tons)	13.2	—	0.5	5.3	7.3	—	27.3	2.6	3.1	8.7	12.0	0.8	51.0	3.7	8.0	12.8	21.3	5.2	75.3	4.9	15.0	16.0	30.2	9.2
	20th August 1955						*27th August 1955*						*3rd September 1955*						*10th September 1955*					
Cane crushed (1000 m. tons)	914	57	188	206	352	111	1158	69	256	253	434	146	1355	79	312	286	502	176	1596	94	379	331	581	211
Sugar manufactured % cane	10.89	10.47	11.22	10.71	10.74	11.31	11.11	10.90	11.49	10.93	10.88	11.55	11.24	11.05	11.65	11.07	10.99	11.71	11.43	11.35	11.85	11.25	11.12	11.91
Sugar manufactured (1000 m. tons)	99.6	6.0	21.0	22.3	37.7	12.6	128.7	7.6	29.4	27.6	47.3	16.8	152.8	8.8	36.3	31.8	55.3	20.6	182.6	10.6	44.9	37.2	64.8	25.1
	17th September 1955						*24th September 1955*						*1st October 1955*						*5th October 1955*					
Cane crushed (1000 m. tons)	1825	108	445	373	654	245	2058	120	513	418	728	279	2282	133	580	460	796	313	2510	147	645	504	868	346
Sugar manufactured % cane	11.58	11.59	12.01	11.39	11.28	11.99	11.74	11.96	12.19	11.56	11.37	11.56	11.87	13.05	12.20	11.68	11.39	12.20	12.00	12.20	12.50	11.79	11.58	12.29
Sugar manufactured (1000 m. tons)	211.7	12.5	53.6	42.5	73.7	29.4	241.7	14.1	62.6	48.3	82.9	33.8	270.6	17.3	70.7	53.8	90.6	38.2	301.2	17.9	80.9	59.4	100.5	42.5
	15th October 1955						*22nd October 1955*						*29th October 1955*						*5th November 1955*					
Cane crushed (1000 m. tons)	2733	161	711	546	937	378	2959	176	777	589	1006	411	3188	190	844	633	1076	445	3385	201	902	671	1138	473
Sugar manufactured % cane	12.11	12.34	12.62	11.88	11.68	12.40	12.18	12.45	12.73	11.98	11.77	12.46	12.33	12.55	12.87	12.06	11.83	12.52	12.37	12.61	12.96	12.13	11.91	12.61
Sugar manufactured (1000 m. tons)	331.0	19.9	89.7	65.1	109.4	46.9	360.4	21.9	98.9	70.6	118.5	50.5	393.0	23.9	109.0	76.4	127.4	56.3	418.7	25.4	116.8	81.4	135.5	59.6
	12th November 1955						*19th November 1955*						*26th November 1955*						*Total Crop Production (Preliminary figures)*					
Canes crushed (1000 m. tons)	3610	215	966	714	1209	506	3822	230	1027	754	1279	532	4034	246	1093	796	1343	556	4229	246	1122	832	1436	593
Sugar manufactured % cane	12.44	12.70	13.01	12.21	11.99	12.66	12.51	12.71	13.10	12.28	12.07	12.73	12.57	12.85	13.17	12.36	12.12	12.75	12.61	12.85	13.22	12.43	12.11	12.83
Sugar manufactured (1000 m. tons)	449.1	27.4	125.6	87.2	144.9	64.0	478.4	29.2	134.6	92.6	154.3	67.7	507.6	31.6	144.0	98.4	162.7	70.9	533.0	31.5	148.3	103.3	173.9	76.0

Table VIII. Evolution of cane quality during 1955 sugar crop.

WEEK ENDING	ISLAND		WEST		NORTH		EAST		SOUTH		CENTRE	
	A	B	A	B	A	B	A	B	A	B	A	B
16th July	—	—	—	—	—	—	12.00	10.84	11.89	10.00	—	—
23rd ”	12.22	10.12	12.58	10.12	12.49	10.15	12.22	10.23	12.22	10.08	—	—
30th ”	12.55	10.54	12.85	10.14	13.01	11.12	12.35	10.35	12.58	10.51	12.65	10.42
6th August	12.77	10.85	13·00	10.31	13.04	11.18	12.61	10.64	12.77	10.87	12.92	10.98
17th ”	13.06	11.21	13.51	10.74	13.13	11.35	13.03	11.20	12.97	11.01	13.18	11.48
20th ”	13.37	11.64	13.92	11.22	13.55	11.86	13.31	11.70	13.24	11.35	13.59	11.98
27th ”	13.50	11.92	13.84	12.33	13.91	12.33	13.47	11.88	13.31	11.50	13.68	12.17
3rd September	13.76	12.17	14.40	12.67	14.12	12.51	13.73	12.16	13.43	11.71	13.73	12.33
10th ”	13.98	12.44	14.68	13.14	14.38	12.74	13.88	12.35	13.56	12.01	13.92	12.66
17th ”	14.07	12.56	14.71	12.84	14.50	12.95	14.00	12.55	13.68	12.14	13.94	12.62
24th ”	14.45	12.89	16.95	13.43	14.85	13.25	14.38	12.95	14.10	12.44	14.33	12.98
1st October	14.45	12.94	14.98	13.24	14.94	13.33	14.38	12.97	14.05	12.47	14.30	12.90
8th ”	14.61	13.19	15.18	13.68	15.07	13.80	14.45	12.98	14.32	12.68	14.39	13.19
15th ”	14.87	13.29	15.51	13.74	15.38	13.88	14.51	12.97	14.59	12.84	14.63	13.32
22nd ”	14.94	13.40	15.48	13.74	15.52	14.05	14.69	13.12	14.63	12.94	14.57	13.28
29th ”	15.12	13.51	15.52	13.99	15.70	14.11	14.87	13.22	14.85	13.07	14.78	13.40
5th November	15.20	13.59	15.55	14.12	15.81	14.17	14.91	13.28	14.90	13.12	14.95	13.67
12th ”	15.22	13.61	15.37	13.96	15.79	14.20	15.08	13.04	15.16	13.30	14.41	13.13
19th ”	15.39	13.65	15.28	13.64	15.98	14.32	15.15	13.43	15.20	13.21	15.01	13.75
26th ”	15.31	13.47	14.68	12.59	16.09	14.31	14 99	13.32	15.08	12.96	14.96	13.72
1st December	14.50	12.81	-	—	15.60	13.91	14.36	12.93	14.14	12.17	14.86	13.71

NOTE: A = *Sucrose % cane.*

B = *Sugar extracted % cane.*

Table IX. 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

NOTE : To convert into millimetres, multiply by 25.4

Table X. Highest wind speed during one hour in miles. Average over Mauritius.

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

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 XI. 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 Metric 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	22,283	116	56	1,145

NOTE: Approximate export of molasses in 1954 amounted to 90,000 metric tons.

Table XII. Variety trend in Mauritius 1930 — 1954.

% Area Cultivated

	Tannas	M. P. seedlings 55,131	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 3337,37161,37172
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

Table XIII. Area planted under different cane varieties on sugar estates in 1955.

Varieties	Island		West		North		East		South		Centre	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
M. 134/32	3625	28.5	14	3.9	1661	76.3	386	20.0	1347	24.3	217	8.5
M. 134/32 (white)	432	3.4	173	47.5	8	0.3	155	8.0	70	1.2	26	1.0
M. 112/34	642	5.0	22	6.0	82	3.7	44	2.2	394	7.1	100	3.9
Ebène 1/37	4000	31.4	72	19.7	116	5.3	954	49.5	1461	26.4	1397	55.2
B. 3337	1363	10.7	—	—	6	0.2	62	3.2	714	11.1	581	22.9
B. 37161	906	7.1	16	4.4	145	6.6	156	8.1	538	9.7	51	2.0
B. 37172	763	6.0	—	—	91	4.1	103	5.3	554	10.0	15	0.5
Other varieties	795	7.9	67	18.5	67	3.5	67	3.7	444	9.2	140	6.0
Total	12726	—	364	—	2176	—	1927	—	5522	—	2527	—

Table XIV. 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

NOTE : *The weight of cane produced on estates in 1954 was : virgins 288,500 tons; ratoons 2,120,000 tons.*

Table XV. Average yield of virgin and ratoon canes on estates, 1947 — 1954 ; tons canes per arpent.

	Island	West	North	East	South	Centre
Virgin	35.2	41.2	34.4	39.3	33.7	34.5
1st Ratoon	32.6	34.7	33.5	33.9	31.8	31.6
2nd ”	30.7	32.7	30.9	32.2	30.0	30.4
3rd ”	28.9	31.3	29.3	31.0	29.5	28.1
4th ”	28.5	30.0	27.5	29.7	28.9	27.2
5th ”	27.7	29.1	26.7	27.0	28.7	27.4
6th ”	27.6	—	26.0	—	28.2	—

Table XVI. List of Crosses

REDUIT AND PAMPLEMOUSSES 1955.

CROSS			Number of crosses made	Number of seedlings obtained
B. 3337	x	Co. 419	1	0
,,	x	Ebène 1/37	4	0
B. 3439	x	,,	2	572
,,	x	M. 423/41	1	1760
B. 34104	x	Ebène 1/37	1	0
,,	x	M. 63/39	2	2860
,,	x	M. 213/40	1	16
,,	x	P. O .J. 2878	1	0
,,	x	R. 366	1	0
B. 37161	x	Ebène 1/37	1	1
,,	x	M. 63/39	2	0
,,	x	P. O. J. 2878	1	0
,,	x	R. 366	2	0
,,	x	R. 397	2	0
Black Tanna	x	P. O. J. 2878	2	8
Co. 281	x	Co. 290	2	0
,,	x	Co. 419	2	0
,,	x	D. 109	1	0
,,	x	M. 63/39	1	0
,,	x	R. 397	1	0
Co. 421	x	Co. 290	1	0
,,	x	Ebène 1/37	1	0
,,	x	M. 99/34	1	0
,,	x	M. 63/39	1	0
,,	x	R. 397	2	3
Ebène 1/37	x	B. 4098	1	18
,,	x	Co. 290	2	3
,,	x	Co. 419	2	1415
,,	x	M. 47/38	3	1294
,,	x	M. 63/39	2	657
,,	x	M. 213/40	1	116
,,	x	M. 423/41	2	1532
,,	x	M. 147/44	1	123
,,	x	M. 381/51	2	1
,,	x	M. 716/51	1	265
,,	x	P. O. J. 2940	2	228
,,	x	P. R. 905	2	253
,,	x	R. 366	2	0
,,	x	R. 397	1	0
M. 134/32	x	B. 4098	1	0
,,	x	Co. 290	1	0
,,	x	Co. 419	4	64
,,	x	Ebène 1/37	24	2800
,,	x	M. 336	2	86
,,	x	M. 233/40	1	270
,,	x	M. 147/44	2	2320
,,	x	M. 381/51	1	0
,,	x	P. O. J. 2940	5	627
,,	x	P. R. 905	5	172
,,	x	R. 366	1	0
,,	x	R. 397	2	2
M. 183/33	x	,,	1	0

CROSS			Number of crosses made	Number of seedlings obtained
M. 112/34	x	M. 336	6	660
,,	x	M. 63/39	2	1573
,,	x	M. 213/40	1	760
,,	x	M. 423/41	2	2020
,,	x	M. 147/44	1	490
,,	x	M. 381/51	2	38
,,	x	P. O. J. 2940	3	119
,,	x	P. R. 905	3	48
,,	x	R. 397	1	0
M. 241/40	x	Ebène 1/37	1	0
,,	x	P. O. J. 2878	1	0
,,	x	P. O. J. 2940	1	0
,,	x	P. R. 905	2	8
M. 311/41	x	M. 336	2	48
,,	x	M. 423/41	2	30
,,	x	M. 147/44	2	10
M. 129/43	x	Ebène 1/37	7	586
	x	M. 63/39	2	864
	x	M. 423/41	2	354
	x	M. 147/44	1	63
	x	P. R. 905	2	177
	x	R. 397	1	0
M. 24/47	x	Ebène 1/37	2	534
,,	x	P. O. J. 2940	1	430
,,	x	P. R. 905	1	10
M. 63/47	x	Ebène 1/37	3	3
M. 381/51	x	,,	3	0
M. L. 3 – 18	x	Co. 290	2	0
,,	x	Ebène 1/37	3	1362
,,	x	M. 63/39	1	610
,,	x	M. 147/44	2	2130
,,	x	R. 366	1	1
P. O. J. 2878	x	Co. 290	2	6
,,	x	M. 147/44	2	66
		Total	181	30466