THE TEA RESEARCH INSTITUTE OF CEYLON

Annual Report for the Year 1963

Part II

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ST COOMBS, TALAWAKELE, CEYLON
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The Tea Research Institute of Ceylon

Staff as at 31st December 1963

Director	A. W. R. Joachim, O.B.E., B.Sc., Ph.D. (Lond.), F.R.I.C., Dip. Agric. (Cantab.)
Deputy Director	J.A.H. Tolhurst, B.Sc. (Reading)
Agricultural Chemistry	
Agricultural Chemist	J. A. H. Tolhurst, B.Sc. (Reading)
Research Assistants	S. Sivasubramaniam, B.Sc. (Cey.)
	W. Bandaranaike, B.Sc. (Cey.)
Senior Technical Assistant	V. Mendis
Assistants	S. Samarasingham
	T. C. Z. Jayman
	E. O. Stuart
	(Mrs.) B. I. de Silva, B.Sc. (Cey.)
	S. Sunderalingam, B.Sc. (Poona)
	K. Govindasamy
Biochemistry	
Biochemist	G. W. Sanderson, B.Sc. (Calif.), Ph.D. (Nott.)
Tea Research Fellow	*R. L. Wickremasinghe, B.Sc. (Cey.), B.Sc. (Lond.), Ph.D. (Sheff.), A.R.I.C.
Research Assistants	R. R. Selvendram, B.Sc. (Cey.)
	G. R. Roberts, B.Sc. (Cey.)
Senior Technical Assistant	T. S. Nathan
Assistants	B. P. M. Perera
	K. Sivapalan, B.Sc. (Cey.)
	V. Fernando
Technology	
Technologist	E. L. Keegel
Research Assistant	*D. Kirtisinghe, B.Sc. (Cey.)
Assistants	L. S. Weragoda
	W. C. A. de Silva, B.Sc. (Cey.)
	C. Kandappah, B.Sc. (Cey.)
Plant Physiology	
Plant Physiologist	U. Pethiyagoda, B.Sc. (Cey.), Ph.D. (Lond.), D.I.C.
Research Assistant	S. Kandiah, B.Sc. (Cey.)
Senior Technical Assistant	M. Piyasena
Assistants	*S. Nagarajah, B.Sc. (Cey.)
	N. S. Rajendram, B.Sc. (Madras)
	G. M. H. B. Wijetunge
	S. Krishnapillai, B.Sc. (Cey.)
Plant Propagation	
Adviser in Plant Propagation	A. V. Richards, B.Sc. (Lond.), M.Sc., (Calif.), Dip. Agric. (Cantab.) A.I.C.T.A., (Trinidad)
Research Assistant	*S. Kulasegaram, B.Sc. (Cey.)
Post-graduate Scholar (Plant Breeding)	A. R. Sebastiampillai, B.Sc. (Cey.)
Assistants	H. R. Solomon
	A. L. J. de Croos
	D. D. Kroon (Passara)
	H. B. Ratnayake (Hantane)
Plant Pathology	
Adviser in Plant Pathology	A. Kerr, B.Sc. (Edin.) Ph.D. (Adel.)
Plant Pathologist	N. Shanmuganathan, B.Sc. (Cey.), Ph.D. (Lond.)
Research Officer	R. L. de Silva, B.Sc. (Cey.), Ph.D. (Lond.), D.I.C.
Senior Technical Assistant	W. W. Redlich, B.Sc. (Cey.)
Assistants	P. V. Arulpragasam, B.Sc. (Madras)
	S. Murugiah
	W. F. Rodrigo, B.Sc. (Cey.)
Entomology	
Entomologist	J. E. Cranham, B.A. (Cantab.), D.I.C.
Research Officer	D. Calnaido, B.Sc. (Cey.), Ph.D. (Lond.) (Hantane)
Research Assistants	D. J. W. Ranaweera
	*W. Danthanarayana, B.Sc. (Cey.)
Senior Technical Assistant	E. F. W. Fernando, B.Sc. (Cey.)
Assistants	C. Shanmugam
	A. Kathiravetpillai, B.Sc. (Cey.)
	H. H. Samarakoon
	K. Thirugnanasuntharan, B.Sc. (Cey.) (Hantane)
Nematology	
Adviser in Nematology	A. Kerr, B.Sc. (Edin.), Ph.D. (Adel.)
Acting Nematologist	N. Shanmuganathan, B.Sc. (Cey.), Ph.D. (Lond.)
Research Assistant	*P. Sivapalan, B.Sc. (Cey.)
Senior Technical Assistant	M. K. Vythilingam
Assistants	P. A. John
	S. Samarajeewa

*Working overseas

NOTICES

General.—The laboratories of the Institute are situated at St Coombs Estate, Talawakele, and letters and enquiries should be addressed to the Director, Tea Research Institute, Talawakele. Telegraphic address: Research, Talawakele, Telephone: Talawakele 44 (Private Exchange).

It is particularly requested that letters should not be addressed to Officers by name. Specimens and other consignments sent by rail should be forwarded to Talawakele Station, c/o Messrs M.Y. Hemachandra & Co., Ltd., Forwarding Agents. *Carriage should be pre-paid.*

Low-country estates should address their correspondence and enquiries to the Low-Country Adviser, St. Joachim Estate, Ratnapura.

Visitors' Days.—The *second* and *last* Wednesdays in each month have been set aside for Visitors' Days at St Coombs Estate and also at the T.R.I. Sub-Station, Gonakelle Estate, Passara, when it is hoped that those interested will visit the station.

Guest House.—The house formerly used for guests is now an officer's residence and it is regretted that, for the time being, no Guest House facilities are available. Those visiting the Institute or the Estate on business, who are unable to arrange accommodation in the neighbourhood, should seek the help of the Director.

Publications.—The Tea Quarterly, Bulletins (New Series), Pamphlets, and Annual Reports, published by the Tea Research Institute will be sent free of charge to Superintendents of Ceylon tea estates over ten acres in extent and to estate agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St Coombs, Talawakele.

Other persons can obtain the publications of the Institute on application to the Director, the post-free subscription being fifteen rupees per annum for persons resident in Ceylon or India and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*.

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REPORT OF THE DIRECTOR FOR 1963

Dr A. W. R. Joachim

Staff

The senior staff position at the end of the year was quite satisfactory despite the losses of the previous year. Mr J. A. H. Tolhurst, Agricultural Chemist was appointed Deputy Director on 6th September and has been of much assistance to me. The following joined the staff during the year: Dr L. H. Fernando, Low Country Scientific Officer, Dr G. W. Sanderson, Biochemist, Dr A. Kerr, Adviser in Plant Pathology, Mr A. V. Richards, Adviser in Plant Propagation, and Mr G. M. Sparkes, Chief Administrative Officer. On the other hand, we lost some senior members of our staff during the period. Chief among these was the Director, Dr D. L. Gunn, C.B.E., whose resignation at the end of February created a void which was difficult to fill. With a man of his experience, drive and capability, the Institute would have made considerable headway in its programme of development had he stayed on for a few years longer. We wish him well in his new sphere of work with the Agricultural Research Council of Great Britain. At the request of the Board, I took over as Director from Dr Gunn and have agreed to carry on until a suitable successor is appointed. Other members of the staff whose resignations during the year must be recorded with great regret are: Mr E. L. Keegel, Technologist; Mr F. H. Kehl, Vegetative Propagation Officer; Dr M. T. Hutchinson, Nematologist, who had been loaned to us under the American Technical Aid Scheme, and Mr W. J. A. van Langenberg, Chief Administrative Officer.

During the year we welcomed back Dr R. L. de Silva, Research Officer in Plant Pathology on the completion of his training in the U.K. We were also fortunate in being able to add to the strength of our Research Assistant staff by 4. Three Research Assistants left for overseas training in September. Mr D. T. Wettasinghe joined the Reading University for studies on weedicides, Mr W. Manipura, the University of Cambridge for research in plant nutrition, and Mr S. Kulasegaram, Wye College, University of London, for postgraduate work in vegetative propagation. Two officers with the necessary training and qualifications — Messrs L. M. de W. Tillekeratne and J. V. Sabanayagam were promoted to the grade of Advisory Officer, the former for Uva and the latter for the Low-Country. The staff position in regard to the junior grades was very satisfactory.

The Board's approval has been obtained for the appointment of a Tea Taster to the Institute to collaborate with the Divisions concerned with tea manufacture and quality.

The list of staff changes during the year is attached.

Buildings

Two semi-detached senior staff quarters were built during the year. Structural alterations to the old Administration block were completed and this provided much needed laboratory accommodation. Additions and improvements were started on two semi-detached senior staff quarters and two intermediate staff flats. A start was made with the addition of a new wing of four bedrooms to the Hostel, and the construction of six minor staff quarters was proceeded with.

The new Biochemistry laboratory was fitted and equipped and made ready for occupation by June, thanks to the efforts of the Biochemist, Dr G.W. Sanderson and the engineering section.

Great difficulty was experienced during the latter part of the year in obtaining materials for buildings projects with the result that unexpected delays have been experienced. An ambitious programme of work has been planned for 1964.

Outlying Stations

St Joachim Estate, Ratnapura, came under the control of the Institute from January, with Mr C. Andrews as Superintendent. The first Visiting agent was Mr R. S. Bean, but he was succeeded by Mr J. W. Craig towards the end of the year owing to ill health. The buildings programme for the Low Country Sub-station on St Joachim Estate was actively pursued during the period and considerable advances were made with the construction of one senior, 3 intermediate, 10 junior and 6 minor staff bungalows. A start was also made with the construction of the laboratory and the factory. The Low Country Committee gave considerable attention to the details of the entire project and particularly in regard to the construction of the factory. The results of its labours will be watched with the greatest interest for the factory, when completed, will be one of the most advanced in the Island incorporating all the new ideas on tea manufacture.

The Clonal Testing Stations at Kottawa in the Galle District, Hantane in the Kandy District and Passara in the Uva District, made valuable advances during the period towards the achievements of their objectives. The extension of the acreage of the Kottawa and Hantane sub-stations to about 50 acres each has been secured in the case of the former and is nearing attainment in the case of the latter. Proposals for the establishment of a Sub-station for Uva typical of the drier parts of the District were actively considered and a search for an area suitable for the project was initiated.

Visits

The number of visitors to the Institute continues to increase. Noteworthy among the distinguished technical visitors during the year was Dr E. M. Chenery, Director of the East African Tea Research Institute, Kenya, who spent three days at St Coombs.

Members of the staff visited Tea Research Stations at Tocklai, Assam and Coonoor, South India, and attended the Annual Conferences of these Institutions.

Library and Publications

Considerable progress was made during the year on the author and subject index to literature on tea. The number of publications received in the Library by way of exchange and purchase during 1963 was 416 and the number of new periodicals subscribed 14. The Tea Quarterly was regularly issued, and comprised part 4 of Volume 33, and parts 1, 2 and 3 of Volume 34. The Monograph on a 'One-day Course for Teamakers' by Mr E. L. Keegel and his staff is still in the press, the delay in publication being due to the scarcity of printing paper.

Research

The reports of the Research Officers detail the work done by the respective Divisions in their particular spheres of activity. But little, therefore, need be

said in amplification. It is, however, necessary to pinpoint certain features of interest relating to work in which some advances have been made.

St Coombs and St Joachim Estates

Record crops were obtained during the year on both estates, the yield on St Coombs being 1445 lbs per acre and at St Joachim the equivalent in green leaf of 1174 lbs per acre. Prices at St Coombs were not, however, as high as In the previous year, one reason being the general fall in tea prices in the Island in 1963.

Advisory Work

The work of this Division is increasing both in scope and intensity. An Advisory Sub-division was established for Uva, as the first of a new phase of development of our extension activities. An Advisory Officer for the Low Country has also been appointed and is now under training.

Low Country

Manurial experiments started on Endane Estate on seedling tea and at Palmgarden Estate on V.P. tea have given results of considerable interest, the response to nitrogen being very marked in the latter and striking in the former when shot-hole borer was controlled by dieldrin spraying. The frequency of application during the cycle has proved to be significant in the Palmgarden trial, the yields rising with increasing frequency. A series of new agronomic and clonal trials has been initiated on St Joachim estate.

Agronomy

A comprehensive NPK trial on 2024 clonal tea has begun to show results which will throw further light on the manuring of young tea under similar soil and climatic conditions. Foliar analyses of material obtained from differently manured plots in controlled shade trials are beginning to show results of significance.

Plant Physiology

Factors relating to dormancy in the tea bush are being elucidated by investigations undertaken by this Division. The problem of variations in the carbohydrate (mainly starch) content of the roots is being studied intensively. The controlled shade trial at St Coombs has shown that a lower yield response to nitrogen is obtained under heavy shade conditions.

Agricultural Chemistry

An outstanding feature of the work of this Division is the increase in the number of field trials on the method and frequency of application of fertilisers and on cultural practices. Reports on responses to zinc are becoming wide spread. Trials show that responses can occur from the earliest plucking rounds in the cycle. Response to nitrogen at levels higher than those applied in practice is possibly related to the type of plucking — short rounds and close plucking.

Entomology

The data of trials with dieldrin for the control of shot-hole borer continue to show that substantial yield increases result therefrom. There may even be an improvement in the response to fertilizer once the borer is controlled.

Evidence of this was obtained from the Endane manurial trial. The 1960-63 series of spraying trials with dieldrin indicated that there was increase of infestation on the sprayed plots in the third year but this was only about half that which occurred on unsprayed plots in the second year.

While there is good evidence now to indicate that there are direct benefits from dieldrin spraying which are worthwhile, the tortrix side effect has proved increasingly troublesome. Trials with the alternate insecticides aldrin and Telodrin have shown that the former is less effective on the parasite *macrocentrus*. Should aldrin effect control of a comparable duration to dieldrin, it would be a useful alternative and cause much less incidence of tortrix.

Plant Pathology

A great deal of attention has been given to the study of the control of Poria. All evidence indicates that the fumigation of Poria patches with 2,000 lb D.D. injected at 6 inches is effective in controlling the disease. A formulation of copper and zinc-fungicide 6011 — has proved to be as effective in controlling blister blight as Perenox. If further tests are satisfactory this fungicide may find wide use on estates where there is zinc deficiency.

Nematology

Trials show that DK1, MO 116, and MO 146 appear to have appreciable resistance or tolerance to meadow eelworms. Rehabilitation tests indicate that survival of nematodes was least in soil under marigolds, more so under Guatemala grass and highest under tea. Even after 10 months with Guatemala grass nematodes have not been eliminated. Potato and *Tephrosia vogelii* were both found to support large populations of meadow eelworms. Evidence was forthcoming that interplanting nematode—infected tea with marigolds results in yield increases.

Plant Propagation

The series of clonal tests carried out at four different climatic zones are beginning to show results at two centres *viz*. St Coombs and Kottawa. Plots with no shade in upcountry areas gave higher yields than those with shade. The T.R.I. 202 series of clones are about the best yielders both at St Coombs and in the low-country. Promising results were obtained in an experiment on the rooting of tea cuttings with Fermate and plant hormone preparations. Clone S 106 showed the most striking results.

Cross-pollination studies started the previous year were continued. Biclonal seedling progeny of TRI 2023 and TRI 2026 made vigorous growth in the early stages but showed differences in morphological characteristics later.

A survey of V.P. tea in Ceylon shows that about 6000 acres are under clonal tea of which about 60 per cent are under TRI clones. The largest extents of clonal tea are in the low-country where over 1000 acres have been cultivated on four estates alone.

Biochemistry

Investigations have been directed to studying the biochemical basis of quality in tea. Interesting results have already been obtained in a comparison of two clones which differed markedly in quality, viz, TRI 777 and TRI 740. Variations in the chemical composition of tea flush have also been studied and marked fluctuations were found to occur in all quantities measured. Investigations on the nitrogen and organic acid metabolism in tea are producing results of interest.

Technology

The comprehensive report of the Technologist deals with matters of considerable interest especially now when tea prices are so competitive. Rotorvane anl C.T.C. manufacture of tea and trough withering are discussed in relation to factors responsible for variations in quality of teas resulting from their adoption.

General

The year has been one of steady progress, though spectacular results cannot be recorded except in one or two instances. A matter which needs specific mention is the issue, at the instance of the Board, of joint recommendations by the officers concerned with the subject of manuring on the levels of nitrogenous manure for tea (1). Emphasis has been placed on the need for simple experimentation on estates with a view to determining optimum yield responses under varied climatic and soil conditions.

There is apparently a good and ready response to the adoption of the recommendations of the Institute in regard to improving both the yield and quality of our teas. Crop production has shown a steady increase since the war and particularly over the past decade, and has now reached the 485 million pound mark. The reasons for this upward trend in yield are obviously the adoption over the period of improved methods of cultivation and bush management, including the use of increasing quantities of nitrogenous fertilizers and the better control of pests and diseases. The higher frequencies of application of fertilizer now in practice as compared with those adopted in earlier years is probably yet another factor towards this result. The contribution of vegetatively propagated tea to production has not yet been of much significance, but the next few years should see this desired effect. With higher yields per acre costs of production would naturally fall and enable our teas to hold their own in our established markets. The prices of our high, medium and low grown teas have, however, declined by 12, 7 and 3 cents respectively as compared with those of 1962. The need for continued vigilance in the maintenance of quality, particularly of our up-country teas, is, therefore, clearly indicated more so as competition from other tea-growing countries is becoming more acute each year.

The last quarter of the year saw evidence of much activity in preparation for the Conference which it was decided to hold in January, 1964.

Acknowledgements

Before concluding this survey of the Institute's activities in 1963, I should refer to the new Scientific Committee which the Board appointed during the year to act as a liaison between the Board and the staff, and to advise on its scientific policy. This Committee has been of the greatest assistance to me and I would express my thanks to them for helping me find solutions to the varied problems coming within the scope of their activities.

I must again acknowledge my indebtedness to Dr F. R. Tubbs, Chairman of our Scientific Advisory Committee in the U.K. and the other members of the Committee for their unfailing help and advice on many matters.

I should also express the thanks of the Institute to the Planting Associations, Agency Houses, Managers and Superintendents of estates for the co-operation they have extended to us in our work, particularly in the carrying out of our experimental programme. Finally I must say 'thank you' to all grades of staff for their loyalty and co-operation during a difficult period.

References

(1) Joachim, A. W. R., Tolhurst, J. A. H. *et al.* (1963). Suggested schemes for level of manuring of mature tea. *Tea Quart.* **34**: 106-110.

STAFF CHANGES 1963

APPOINTMENTS

Senior Staff

Dr A. W. R. Joachim, Director, from 28th February
Dr L. H. Fernando, Low Country Scientific Officer, from 1st January
Mr C. Andrews, Superintendent, St Joachim Estate, from 7th January
Dr G. W. Sanderson, Biochemist, from 1st February
Dr U. Pethiyagoda, Plant Physiologist, from 15th February
Mr G. M. Sparkes, Chief Administrative Officer, from 1st August
Dr A. Kerr, Adviser in Plant Pathology, from 11th September
Mr J. A. H. Tolhurst, Deputy Director, from 6th September
Mr A. V. Richards, Adviser in Plant Propagation, from 1st October
Dr N. Shanmuganathan, Plant Pathologist, from 6th September

Intermediate Staff

Mr G. R. Roberts, Research Assistant, Biochemistry Division, from 1st January
Mr L. M. de W. Tillekeratne, District Advisory Officer, Uva, from 1st August
Mr J. V. Sabanayagam, Research Assistant, Advisory Division, from 1st November
Mr S. Sandanam, Research Assistant, Agronomy Division, from 1st November
Mr R. K. Nathaniel, Research Assistant, Advisory Division, from 4th November
Mr S. Sivasubramaniam, Research Assistant, Agricultural Chemistry Division, from 1st December.

Junior Staff

Mr A. Rajendra, Technical Assistant to Entomologist, Hantane, from 1st February

Mr V. Kodagoda, Clerk/Typist, from 1st April

Mr G. A. K. de Silva, Accounts Clerk, from 10th April

Mr K. Govindasamy, Technical Assistant, Agricultural Chemistry Division from 22nd April

Mr H. D. Jayasinghe, Technical Assistant, Low Country Station, Ratnapura, from 1st July 1963

Mr G. M. H. B. Wijetunga — Technical Assistant, Physiology Division, from 1st July

Mr K. L. de Alwis, Filing Clerk, from 1st July

Mr J. N. Apasinha, Clerk/Typist, from 1st July

Mr H. H. Samarakoon, Technical Assistant, Low Country Station, Ratnapura, from 5th August.

Overseas Training

Mr D. T. Wettasinghe, Research Assistant, Advisory Division, left on 11th September, for post-graduate studies at Reading University, England

Mr W. Manipura, Research Assistant, Agronomy Division, left on 20th September, for post-graduate studies at Cambridge University

Mr S. Kulasegaram, Research Assistant, Vegetative Propagation Division, left on 11th September for post-graduate studies at Wye College, University of London

Dr R. L. de Silva, Research Officer, Pathology Division, returned on 29th September.

Resignations

Dr D. L. Gunn, Director, on 27th February
Mr H. M. R. Bandara, Clerk/Typist, on 1st January
Mr G. B. Rajapakse, Technical Assistant, on 11th March
Mr U. L. M. de Silva, Technical Assistant, Low Country, on 31st March
Dr M. T. Hutchinson, Nematologist, on 31st March
Mr W. J. A. van Langenberg, Chief Administrative Officer, on 30th August
Mr E. L. Keegel, Technologist, on 30th September
Mr F. H. Kehl, Vegetative Propagation Officer, on 13th December

Transfer

Mr A. R. M. Hassim, Technical Assistant to Low Country Station, Ratnapura, on 8th April

On Leave

Mr C. B. Foster-Braham, Chief Advisory Officer, from 11th August to 12th October
Dr H. N. Hasselo, Chief Agronomist, from 28th August to 5th September
Mr J. E. Cranham, Entomologist, from 1st July to 29th September.

REPORT OF THE AGRICULTURAL CHEMIST FOR 1964

J. A. H. Tolhurst, B.Sc.

General

Staff

It is encouraging to be able to report at last that the Division achieved a proper complement of Staff with the appointment of two Research Officers. Mr S. Sivasubramanian assumed duties in December while Mr W. M. Bandaranayake will join us at the begining of 1964.

Mr S. K. Govindaswamy was appointed in April, but the second vacancy for a field officer remains open.

The Head of the Division was appointed Deputy Director in September, in addition to his normal duties. For some months prior to this he had been required to investigate the need for new laboratory and office space on St Coombs, and to prepare an appropriate building programme. In recent years the increase in staff had been allowed to outstrip the provision of working accommodation, to the extent that some Divisions have had to accept cramped conditions. The main laboratory had also suffered a steady conversion to makeshift storage space for field equipment and manures. With the enthusiastic co-operation of the staff a start was made to rectify matters, but the full benefit cannot be expected within another year or two.

The Deputy Director was also required to investigate the perennial problem of the relation between St Coombs Estate and the Scientific Divisions. An improvement has been achieved in several respects, and it is hoped that future developments will consolidate the ground so far gained. The proposed increase in field trials will necessitate careful organisation if their heavy labour requirements are to be met promptly and efficiently, but without undue interference with Estate working.

Participation in discussions aimed at co-ordinating the work of Divisions occupied a considerable amount of time. Although this, and other problems, are certainly of the utmost urgency if the staff is to be utilised efficiently, it has to be appreciated that the work of the Agricultural Chemist is bound to be curtailed until such time as a smooth-running organisation is attained.

Advisory

Estate visits, numbering about 30, were fewer than in the past. Over 150 advisory letters were written, omitting those which were dispatched by the Advisory Division after consultation.

Field Experiments

1963 was notable for the expansion in our programme of trials on St Coombs, including a large series of short-term, but very exacting, manurial trials on young tea. Tribute is due to the staff for enabling so much extra work to be contemplated. Control of the labourers, particularly in respect of plucking, was noticeably easier following changes introduced by Mr Tennekoon Superintendent, on St Coombs Estate itself. Designing long-term trials on existing seedling tea inevitably ends in a compromise between the desire to include as many treatments as possible, and the necessity of restricting each trial to limits imposed by the land and plant population available. The help

of the Statistician has here been invaluable. It was felt that the use of seedling tea offered certain advantages over the use of specially planted clonal plots. The trials aim to elucidate some of the broad questions pertaining to the use of manure and to soil cultivation. Detailed studies may be possible in the future within some of the designs themselves. Bush management remained as stated in the previous report.

1. *N. P. K. Trial: No. 3 Field, St Coombs*

Salient features will be included in a paper to be presented to the Thirteenth Conference early in 1964 (Tolhurst, 1964), and details of manurial treatments were given in the Report for 1962.

Magnesium treatment in the second year of this cycle was continued on three blocks, with two foliar sprays each of 12 lb epsom salts per acre. Deficiency symptoms appeared late in 1963 on a few bushes in all blocks, whether receiving magnesium or not, but were confined to the lower leaves of rapidly developing side branches. Zinc sulphate sprays were continued.

Sporadic drought from November 1962 to March 1963 imposed a check on growth, especially in those blocks sited on the tops of small hummocks. Weather conditions in the greater part of 1963 were favourable and the rapid response of both crop and side-branch development was encouraging. By the end of the year the better-manured plots had formed a good cover. Frame development on all plots was good, with the exception of the zero-potash plots.

Yield response to nitrogen increased steadily as the bushes expanded laterally, and a more definite response to the highest level of potash also appeared. An overall depressing effect of the highest level of phosphate was still evident, but appears to be absent where nitrogen and potash are applied at the highest levels. It is probable that the design of this trial will not permit a proper evaluation of N.P.K. interactions, and we are prepared to rely on newer trials for more detailed examination of this. It is hoped that circumstances will never again be such that a long-term trial has to suffer partial neglect at a critical stage. The potential value of this trial, started in 1931, was severely and perhaps permanently damaged in this way.

One of the most valuable points now to be gleaned from it is the unexpectedly high yield response to manure, especially nitrogen, of poor-jat tea following hard pruning. This will be stressed at the Conference as it is felt that the point may be of wider application. It is clear that these plots are capable of responding to more than 180 lb N per annum, once the nucleus of a new frame was formed, and before the wood has thickened appreciably. It is of interest to speculate on the yield-nitrogen relation once the frames are fully developed.

These plots also have a value for investigating, by miniature-manufacturing techniques, the relation between extreme manurial treatments and manufacturing properties. Arrangements were made so that Biochemistry Division could begin, in December, a systematic manufacture of the flush from certain of the treatments.

2. *Phosphate Manurial Trial: No. 13 Field, St Coombs*

This trial was concluded in June and a full report published in the Tea Quarterly (Tolhurst, 1963a). After resting for two months, with additional manure, the plots were pruned in September. Although weather was favourable thereafter, and the newly developed frames had every appearance of ample vigour, recovery has to-date been poor. Buds tended to break from the base of thick young branches rather than along their whole length. This phenomenon has been seen in recent years on several estates and has caused

concern. Severe blister-blight damage to the soft stems occurred during a warm and misty period in December. Routine copper spraying, using a mist-blower, had been in progress but had clearly been inadequate to cope with the unusual conditions. Heavier spraying with knapsacks was adopted for a few rounds.

It is intended, after uniform treatment during the first year, to use these plots for a Frequency-Nitrogen Trial,to investigate the relation between two levels of N split between 2, 3, or 4 applications each year.

3. *New Manures' Trial: No.9 Field, St Coombs*

The fourth year of the cycle, and the second full year of the trial, ended in June. No significant yield differences resulted from the use of three forms of nitrogen at either of the two levels. It should be noted that, by chance, most of the manure applications to-date were made during periods of little rain In the coming cycle more normal weather conditions may affect the results differently, particularly with respect to the urea treatment.

During this final year the two levels of nitrogen, 150 and 300 lb N per acre, were associated with yields of approximately 1,500 and 1,900 lb. During the previous year, when 125 and 250 lb N (not 275, as reported earlier) were applied, yields were 1,800 and 2,000 lb dry weight.

Pruning was done in October, two blocks being collar-pruned and two receiving a cut-across with no cleaning out. This latter style resulted in large frames with ample healthy young branches, well spaced. Recovery to-date, in spite of expectations, has been slow, even allowing for blister-blight damage in December.

4. *Zinc Sulphate and blister-blight control*

A trial was carried out on tea in the last year of its cycle, St Coombs, using additions of zinc sulphate, epsom salts and potassium nitrate, singly or in combination, to Perenox sprays. The abnormally mild early monsoon inhibited the expected build up of blister blight, and the very small differences in infestation resulting from the treatments must be described as inconclusive.

5. *Foliar-spraying Trial: No.9 Field, St Coombs*

The plots, which were pruned in November 1962, were brought into plucking in February. Treatments comprised:—Zinc sulphate sprays at 0, 10 and 20 lb per acre per annum; spraying frequencies of 2, 4 and 6 per annum; nitrogen (soil application of sulphate of ammonia) at 75, 150 and 225 lb N per annum. The design is a full 3^3 factorial in twofold replication. Phosphate and magnesium are presently withheld and potash is applied at a low rate.

It should be possible to determine the relation between the level and frequency of application of zinc sulphate within a comparatively short period, since it was found that good response to zinc sprays was shown very soon after the tea came into plucking. To-date, there appears to be little difference in effect between the three frequencies, but the data are drawn from the rather abnormal first "year", when sprays were condensed into only 8 months of plucking. Response to the two higher levels of zinc has been persistent through out, while response to nitrogen appears to be increasing. Eventually the design of this trial would allow ample scope for substitution or superimposition of other spray treatments. Magnesium would be the obvious first choice, as deficiency symptoms began to appear late in the year.

The most interesting feature has been the high yields obtained from the start of plucking. Weather from February to August was generally good, and yields of over 200 lb per acre per month were frequently obtained from the 225 lb N treatments. Yields were still at the same level in November and December in spite of the increased spread of the bushes. There was an indication, supported by observation of 4 extra zero-nitrogen plots, that the residual effect of pre-pruning manuring began to drop sharply after the eighth month of this cycle.

This area, in the same lay-out, had been used for the 1962 zinc-copper trial and by the end of 1963 some plots had received 50 lb zinc sulphate per acre over 18 months. The fact that these plots continue to show response to zinc is of interest.

Tipping weights showed no relation to the 1962 pre-pruning zinc treatments, and a similar result was obtained from the 8Z Plots (Annual Report, 1962), where total growth after pruning was removed, dried and weighed.

Eelworm damage was detected in several areas and marigold seed was broadcast.

6. *Manure-Timing Trial: No. 13, St Coombs*

This is the first of the 1963 series of new trials and has been in existence long enough to warrant detailed comment. An area of No. 13 Field had been planted in 1934 in regular blocks for experimental purposes, and was considered suitable for this investigation. Plucking, in 1962 before the Division acquired the area, had been very hard and the shade-tree density was felt to be too high for the moderately steep North slope. The tea was rested, with several foliar applications of various nutrients, for 10 weeks from mid-February, and all dadaps were removed without ring-barking. Previously, large albizzias had been removed, also without ring-barking. Grevilleas were heavily lopped and ring-barked.

In view of the treatments to be applied, pruning will be done in mid-1964, and a long uniformity period could be contemplated. To-date, manuring has been at a low level, totalling 86 lb N per acre for the four applications since February, and nitrogen-deficiency symptoms have been frequently observed. It is therefore of interest to quote that yields, once the bushes had recovered from "tipping", rose rapidly to about 140 lb per acre per month.

It is intended to investigate the effect of two levels of nitrogen at the last application 3 months before pruning, in conjunction with three levels of nitrogen at either 2 or 4 months after pruning. Two blocks will be plucked vigorously for the last 6 months of the cycle, and two will be allowed to develop a considerable quantity of new maintenance foliage.

The possibility of a relation between recovery from pruning and the size and timing of the manure doses straddling pruning, has occupied our minds for many years. Apart from an assumption that a starved bush could not be expected to recover properly, we have hitherto been unable to hold out hope of conclusive experimental evidence. It should not be forgotten that over-generous nitrogenous manuring close before pruning might have a deleterious effect. One of the above treatments is designed to cover this contingency. Should the effects of the two extreme plucking treatments prove to be large, it would suggest that further studies should move to another Division. The broad subject of recovery from pruning, to judge by results from our existing trials and from unexpected disappointments on estates, seems to warrant detailed study from many aspects.

An interesting and unexpected occurrence of *Ustulina Zonata* (Charcoal root disease) caused concern late in the year, when it was seen that the outbreaks were leading to multiple vacancies in a few areas. Fortunately twelve extra plots were available, and a re-arrangement of numbering was possible before differential treatments began. It is hoped that the longer-term value of these plots will not be threatened. Ustulina had not hitherto been detected on St Coombs and it seems possible that the removal of shade trees without ring-barking led to its development. This could be a point of wider importance, since in practice several species of trees are often not ring-barked before removal.

7. *1963 Mature tea trials: St Coombs*

Three additional trials were marked out and need only be listed briefly.

7.1. Adjoining the above trial, Item 6, is one to investigate the relation between forking, manure applications, and season. This is of simple design and is especially aimed at providing material for chemical studies of manure penetration in the soil profile and nutrient uptake by the bush.

7.2. Adjoining part of the N.P.K. Trial in No. 3 Field, and on similar poor-jat tea, is a more comprehensive Forking Trial. Manuring will be uniform and related to levels adopted in the N.P.K. Trial. Manure application will be kept away from forking operations.

7.3. In No. 12 Field, adjoining No. 13 but on a South-east slope, a trial has been planned to study the effects of distribution of two annual levels of nitrogen according to various patterns throughout the cycle. Subsidiary treatments of pruning will be confounded with the eight blocks. The area is unusual in that a grid of drains divides the slope into roughly similar plots. Treatments and records will be adjusted to the bush population. The high replication should be ample to reduce possible error arising from differential effects of the boundary drains.

8. *Young-tea trials*

8.1. A series of manurial and cultivation trials has been planned in No. 9 Field St Coombs. By 1965 six areas will have been rehabilitated for 2, 1 and 0 years under guatemala grass. Preliminary trials in 1964 will emphasise points relating to manure-placements and the use of relatively new manures, urea-formaldehyde (18% N), potassium metaphosphate, etc. (Tolhurst, 1963 b). Four clones were established in the nursery as it was considered unwise to rely on results from only one clone. Knowledge of rooting habits of clones would have been of great value for this work, but was not available apart from our own observation of shallow rooting of DT.1 in the nursery. Clones T.R.I. 2023, 2142 and Clone Cy. 9 were also struck.

Nematology Division is also using those areas for an investigation into the fate of meadow nematode in relation to the length of the rehabilitation period under guatemala grass.

The original planting of the grass, in May, suffered badly from damage by a stem-boring caterpillar, still unidentified, which often destroyed all the leaf growing-points. The setts were infested before planting and the presence of the larvae was not readily detectable until the setts had withered. This crop has been remarkably free from pests or diseases and this is the first known instance of such trouble.

The setts were planted on an accurate 3 × 2 foot grid, so that the tea could be planted in precise relation to the grass root systems. Micro-plots of 4-8

plants and numerous treatments will involve considerable care if the necessary precision is to be achieved. This could not have been contemplated without the larger staff now available.

8.2. In November, with the co-operation of Dr Fernando, a trial with clone 2023 was planted on St Joachim Estate, to investigate the effects of surface placement of three manure mixtures. T. 200; similar but with blood meal replacing the sulphate of ammonia; similar to the second mixture but omitting the kieserite.

It was desired to study the potential toxic effects of mixtures with varying proportions of readily soluble inorganic fertilisers, and the doses and methods of placement were selected accordingly. Dry weather followed in December and will no doubt help to ensure that the trial will be able to produce damage at least from extreme treatments.

8.3. Again with Dr Fernando's co-operation, it was possible to include three forms of nitrogen on a newly-planted manurial trial at Kottawa. Clone 2023 was again used. Sulphate of ammonia, urea, and hoof-and-horn meal treatments were confounded with blocks. It is intended to continue these treatments only for the first 2 or 3 years, during which time the maximum effect is likely to be detectable, if at all.

9. *Nursery-Manurial Trials: St Coombs*

Several preliminary trials were started to study the possibility of using slowly soluble manures as pre-rooting treatments. The alkalinity of certain otherwise useful products is a disadvantage, and ways of overcoming the difficulty are being sought. Clones DT. 1 and T.R.I. 2024 have been used, and to-date the latter has shown itself to be slightly damaged by alkaline manures, under certain conditions.

10. *Miscellaneous*

10.1. The question of growing legumes in place of guatemala grass at lower elevations is being investigated by the Low-Country Scientific Officer, and co-operation was sought from the Agricultural Chemistry Division. A detailed manurial trial on one legume seems fated to suffer from the early drought which followed sowing in November. A repeat is planned.

10.2. A mishap following pruning of clone 2024 on Hantane (T.R.I. Sub-Station area) ruined the chances of continuing a small experiment, but fortunately seems to have supplied information of considerable value in another respect.

These bushes were pruned at the same time as other adjoining areas of 2024 and other clones. The only way in which treatment differed was in the removal of all thin branches from those plants within the plots. This meant that most frames had no foliage after pruning and none had more than 10-20 leaves. Favourable weather followed the pruning, early October, and recovery outside the plots was excellent. Within the plots, 75% of the bushes had died by the end of the year, and all of the remainder were so badly damaged by sun-scorch that it seems unlikely that the few weak shoots springing from some branches will suffice to make the plants worth saving.

This dramatic result, at 2,500 feet elevation and on well-grown bushes 2 years old, suggests that, at least for clone 2024, a detailed study should be made of the effects of different types of pruning at elevations considerably higher than this, and where lungs are not normally considered essential.

Plant Nutrition

1. Zinc sulphate spraying has been accepted on many estates as routine, but it is not always appreciated that detectable yield response need not necessarily follow. Tea which is not suffering from zinc deficiency can not be expected to show such a response, of course. Interest in separate zinc sprays is being encouraged, partly because supervision is likely to be good, compared with the routine copper fungicide spraying with zinc additive. A trial has been marked out on St Coombs to study the efficiency of zinc oxide in curing zinc deficiency. The fungicidal efficiency of a zinc oxide-cuprous oxide mixture has been reported on by the Pathology Division in this publication.

Zinc deficiency symptoms appear to be increasingly common in nurseries and, to a lesser extent, in young clearings. Drenching sprays of a 2% zinc sulphate solution plus a wetter have been found to be safe over a wide range of clones and weather conditions. Frequent sprays in the nursery would seem to be a wise precaution. Once plants are in the field the main consideration is obviously that of supervision, to avoid too great a wastage of the spray.

Very few reports have been received of damage from any zinc sprays. One case was reported of necrotic spotting in a multiplication plot which had been allowed to grow up more than usual. Thick deposits of the blue zinc sulphate-cuprous oxide reaction product were found to have accumulated on the undersides of the leaves, coinciding with the damaged areas. Accumulations on the upper surface were much smaller and were not associated with damage. A trial was made on St Coombs and it was found that out of over 30 clones most were susceptible to heavy spray accumulation on the lower surface of the leaf. Junctions of main veins clearly acted as dams for the excess spray. Bushes in dense multiplication plots would be particularly likely to receive overdoses unless great care were taken.

2. Magnesium deficiency symptoms in mature tea appear to be attracting more attention in recent years, and in our opinion their importance is sometimes exaggerated. Incidence in nurseries is very low, and is less in young clearings than we used to see. It is still not possible to draw conclusions from magnesium treatments in our manurial trials, but it is probable that the eventual removal of other limiting factors will clarify the position.

3. Potash deficiency symptoms appear to have lessened on several estates which have been under observation for a few years. The use of manure mixtures richer than usual in potash has become popular in recent years, and would appear to have been justified in some cases. It is fortunate that the N.P.K. Trial on St Coombs is now showing a more noticeable potash effect, and it is hoped that experimental evidence will soon be forthcoming to guide the trends of potash manuring in practice. It has also been noticed that manganese toxicity symptoms have tended to show the same decrease on the above estates.

4. *Nutrient foliar sprays.*—Again, interest has grown in this method of manuring and estates are more ready to contemplate relatively high-volume sprays than seemed likely even a year ago. This has led us to take up the question of urea sprays in more detail, with reference to the factors influencing leaf damage. This is quite clearly a complex matter, and many qualitative trials showed that it is not yet possible to predict the degree of damage to be expected from urea sprays of various concentration. A quantitative trial is planned to study this piont, and to estimate the effect on yield resulting from leaf scorch.

A 50% solution of epsom salts, sprayed without a wetter at up to 100 gallons per acre caused only a trace of damage to the edge of the youngest unfolding leaves.

5. *Leaf Analysis.*—Progress continues, and the newer trials, of other Divisions as well as our own it is hoped, will contribute useful material. It seems to be essential to base this work on trials where correlation between plant growth and treatment can be assessed. The tendency to analyse isolated samples and to attempt to judge the results by comparison with an assumed "average" value is noticeable in Ceylon, and is to be deplored. The peculiar nature of the method of gathering crop from the tea bush would seem to point to the utmost caution in attempting to predict the significance of the proportion of nutrients in any given leaf.

Results from our trials to-date underline this warning. Variations in nutrient content of the uppermost mature leaves are often much smaller than would be expected from consideration of either the manurial treatments or the yield responses.

Publications

As a member of a committee set up to co-ordinate ideas on the practice of manuring, and to formulate a practicable advisory policy, the Agricultural Chemist contributed towards a paper in the Tea Quarterly for September 1963, Volume 34, Part 3-"Suggested Schemes for level of manuring of mature tea".

TOLHURST, J. A. H. (1963). Concluding report on a phosphate manurial trial: St Coombs. *Tea Quart.* **34:** 144-147.

TOLHURST, J. A. H. (1963). Manganese deficiency symptoms of tea. *Tea Quart.* **34:** 148-149.

TOLHURST, J. A. H. (1963). Manuring young tea. Placement and new types of fertiliser. *Tea Quart.* **34:** 188-192.

TOLHURST, J. A. H. (1963). A review of present ideas on hard pruning. *Tea Quart.* **34:** 197.

References

TOLHURST, J. A. H. (1963, a). Concluding report on a phosphate manurial trial: St Coombs. *Tea Quart.* **34:** 144-147.

TOLHURST, J. A. H. (1963, b). Manuring young tea. Placement and new types of fertiliser. *Tea Quart.* **34:** 188-192.

TOLHURST, J. A. H. (1964). Observations on the progress of certain manurial trials on St Coombs. *Tea Quart.* **35:** (in press).

REPORT OF THE CHIEF AGRONOMIST FOR 1963

H. N. Hasselo, Dr Ir

A. General

I was on overseas leave from June to September and visited several research stations. Mr W. B. Manipura, who acted for me during this time, left for U.K. in September 1963 for further studies at Cambridge University. Mr A. S. Sandanam, B.Sc. (Cey.) was appointed Research Assistant on 1st November, and Mr M. Sikurajapathy, B.Sc. (Cey.) will assume duties as Technical Assistant early in the new year.

B. Field Experiments

1. *NPK-fertilizer trial*

1.1. *Growth measurements*

The design of this trial planted in June 1962 with clone T.R.I. 2024 has been discussed in the previous Annual Report (Hasselo, 1962).

The height and number of leaves of all the plants were recorded in February and April, whilst stem-diameters at 2″ above ground level were measured in April, June, August and December. Diameters at ground level of all the plants were taken in December only. The plants were pruned down to a level of 12″ in June 1963. A second cut-across at 15″ was given in December, whilst selective pruning of vigorously growing shoots down to between 12 and 14″ was done in October. The weights of these three prunings were recorded on a per plot basis.

It would appear from Fig. 1 that the stem-diameter increment was larger in the two-monthly period after tipping in June than in the preceding and subsequent periods. Differences in mean diameter between the blocks amounted to maximally 14% throughout the period under consideration, *i.e.* from April till the end of the year. The total increase in diameter since April was lowest in block I, *i.e.* 6.3 mm. Compared with block I, the diameter increase in blocks II, III, IV, V and VI was 1%, 1%, 16%, 8% and 3% higher respectively. If expressed in the total increase obtained in surface area (mm^2) since April, assuming the stem-circumference to be a perfect circle, the mean surface area of a cross-section of the plants of block I increased by 112 mm^2, of block II by 125 mm^2, and of blocks III, IV, V and VI by 123, 138, 135 and 120 mm^2 respectively. These differences, amounting to more than 20%, were however not significant. The mean increase in diameter was about 1.75 mm per 2 monthly period. This figure compared favourably with a mean increase per 2 months of 1.50 mm obtained for 15 month old seedlings in the rainy season in the Cameroons in West Africa (Hasselo, 1961).

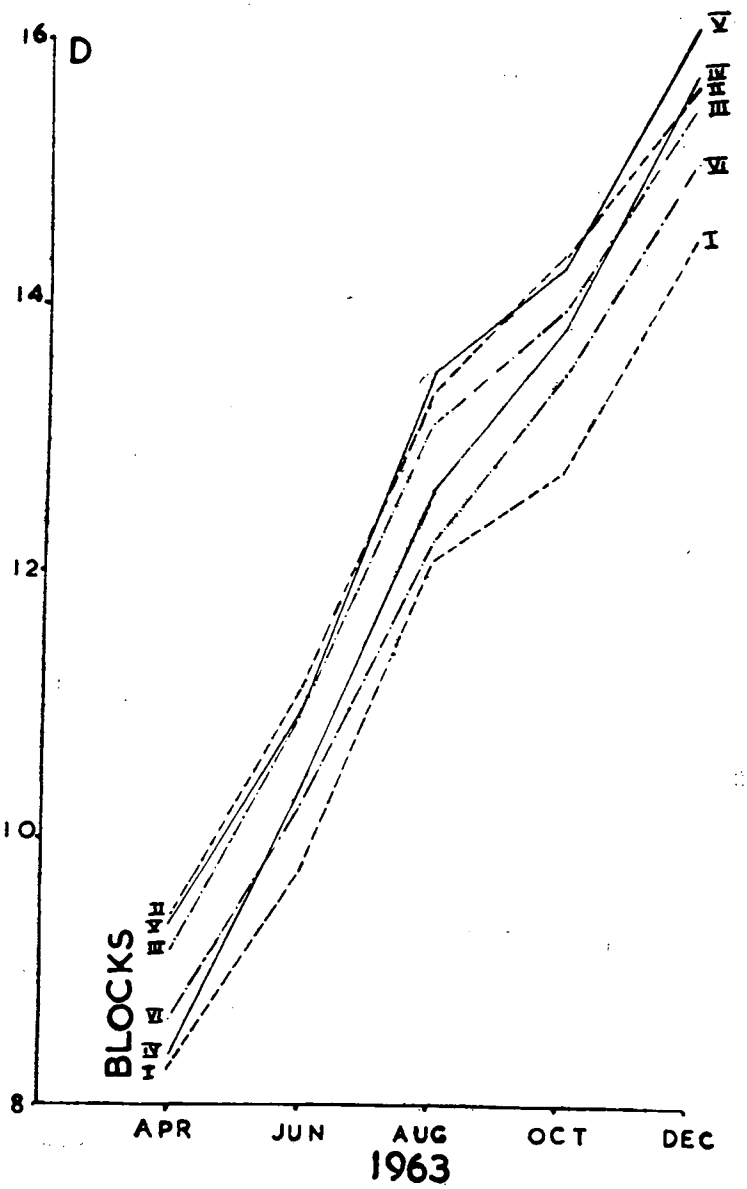

Figure 1 — Stem diameters (D) in mm at 2″ above ground level. Means of 360 plants per block.

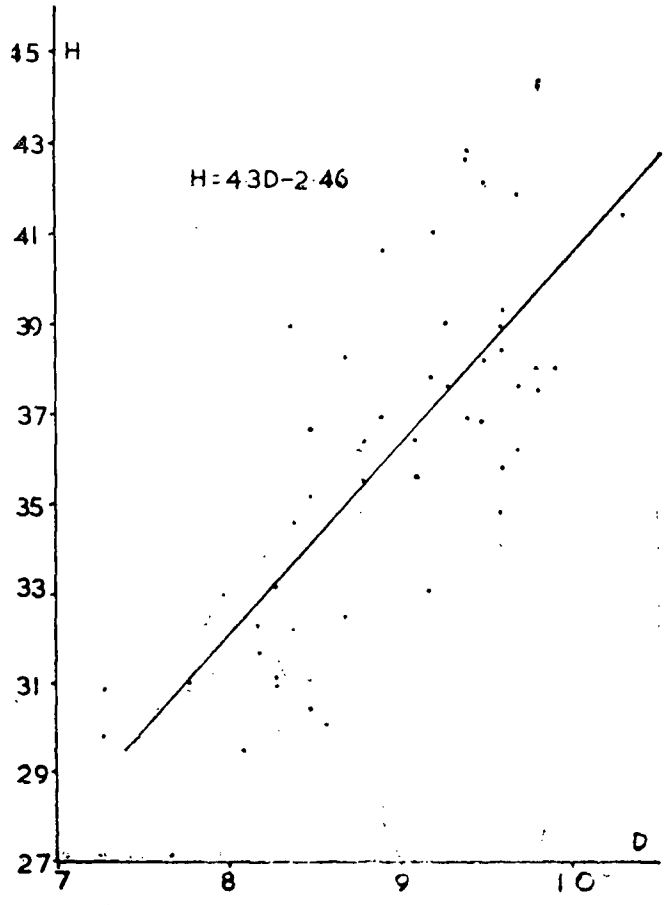

Figure 2 — The relation between mean stem diameter (D in mm at 2" above ground level) and mean plant height (H in inches) in April 1963. (Mean of 36 plants per plot).

TABLE 1.—*Test for linearity: regression height (H in inches) on diameter (D in mm) April,* 1963

Diameter groups	7.1–7.5	7.6–8.0	8.1–8.5	8.6–9.0	9.1–9.5	9.6–10.0	10.1–10.5
Frequency	2	7	15	8	13	14	1
Mean height	30.4	31.0	33.1	35.6	38.5	38.5	41.4

	d.f.	S.S.	Variance
Diameter groups	6	55,573	
Linear regression	1	52,670	
Deviation from Lin. Regr.	5	2,903	580.6 (not significant)
Error	53		792.9

It will be seen from Fig. 2 and table 1 that there was a highly significant (P0.001) and linear relationship (r =0.78) between height and diameter of the plants in April 1963. An increase in diameter of 1 mm corresponded with a height increment of 4.3 inches.

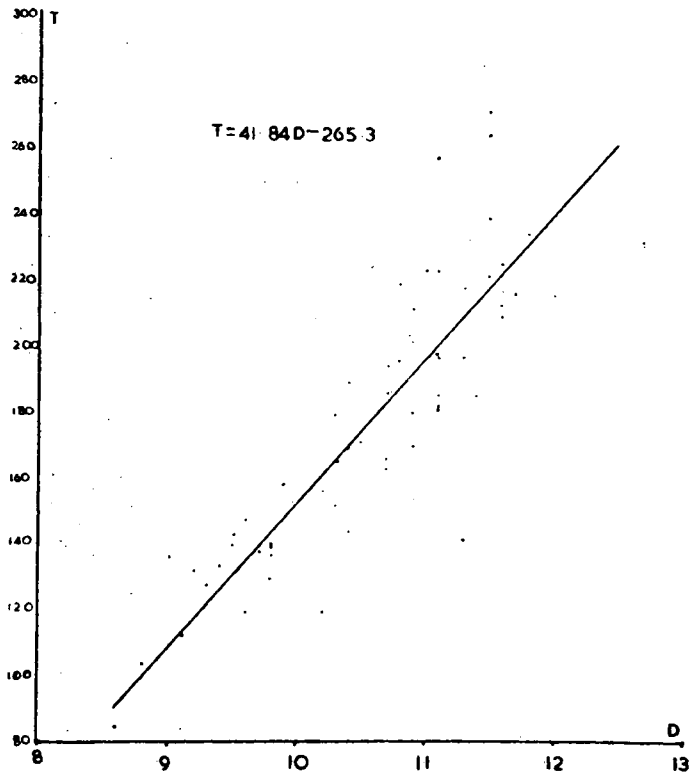

Figure 3 — The relation between mean stem diameter (D in mm at 2″ above ground level) per plant per plot of 36 plants and tipping weight (T in g/plant/plot) at a tipping level of 12″ (June 1963.)

TABLE 2.—*Test for linearity: regression tipping weight (g/plant) on diameter (mm) June* 1963

Diameter groups	8.6–9.0	9.1–9.5	9.6–10.0	10.1–10.5	10.6–11.0	11.1–11.5	11.6–12.0	12.1–12.5
Frequency	2	7	8	9	12	14	6	2
Mean tipping weight	93.5	132.0	138.4	160.2	193.8	215.1	217.8	244.5

	d.f.	S.S.	Variance
Diameter groups	7	84,870	
Linear regression	1	82,253	
Deviation from Lin. Regr.	6	2,617	436.1 (not significant)
Error	52		461.9

It will be seen from Fig. 3 and table 2 that there was an even closer ($r = 0.88$) and linear relationship ($P0.001$) between diameter and tipping weight (tipping level = 12″), an increase of 1 mm in diameter corresponding with a tipping weight increment of 41.8 g/plant. Assuming linearity, extrapolation of the regression equation would suggest that tipping weight would be nil at a diameter of 6.34 mm. (for $T = 0$; $D = 6.34$). In other words, the height of the plants at 6.34 mm diameter would not have exceeded above the tipping level of 12″. The regression equation (Fig.3) would also indicate that, at a diameter of 6.34 mm, 265.3 grams of plant material had been produced above the ground, *i.e.* below a level of 12″ or about $265.3/6.34 = 41.8$ grams per mm diameter. (*N.B.* In order not to complicate the discussion, the plant material produced between ground level and 2″, at which level the diameters were measured, was ignored as being negligible). Hence, the same amount of plant material per 1 mm diameter would seem to have been produced below the tipping level of 12″ as shown by the regression coefficient ($b = 41.84$) of Fig. 3 for diameters between 7.5 and 10.5 mm. Expressed differently, the regression line of Fig. 3, if extended linearly downwards, would cross a point near the origin, *i.e.* the point where at a diameter of nil, the weight of plant material produced would also be nil. These observations would suggest that the relationship between diameter and plant material produced is also linear at diameters smaller than those actually measured in Fig. 3.

However, these findings would not seem to be in line with those shown in Fig. 2. According to Fig. 2 the mean height of the plants at a diameter of 6.34 mm was 24.8″, or 12.8″ higher than the tipping level, so that at a diameter of 6.34 mm plant material must have been produced above the tipping level of 12″. Accepting a linear relationship between weight of (above ground) plant material and diameter, a possible explantaion for these contradictory findings would be that the production of plant material:

(*a*) for plants with a height of up to 12″ was confined to the growth taking place below 12″ height;

(*b*) for plants with a height of between 12″ and maximally, 36″ (maximally, because it would appear from Fig. 3 that at diameters larger than 9 mm, consequently heights higher than 36″ (Fig. 2), an increase in diameter is entirely reflected in the growth occurring above the tipping level of 12″) was due to

1. extended but decreasing growth of the plant parts situated below 12″ and

2. increasing production of plant parts situated above 12″.

(*c*) for plant heights of minimally 36″ was entirely due to the plant parts situated above 12″ and little or none to the plant parts below 12″.

This probable sequence in growth rate of plant parts situated below and above 12″ is shown schematically in Fig. 4.

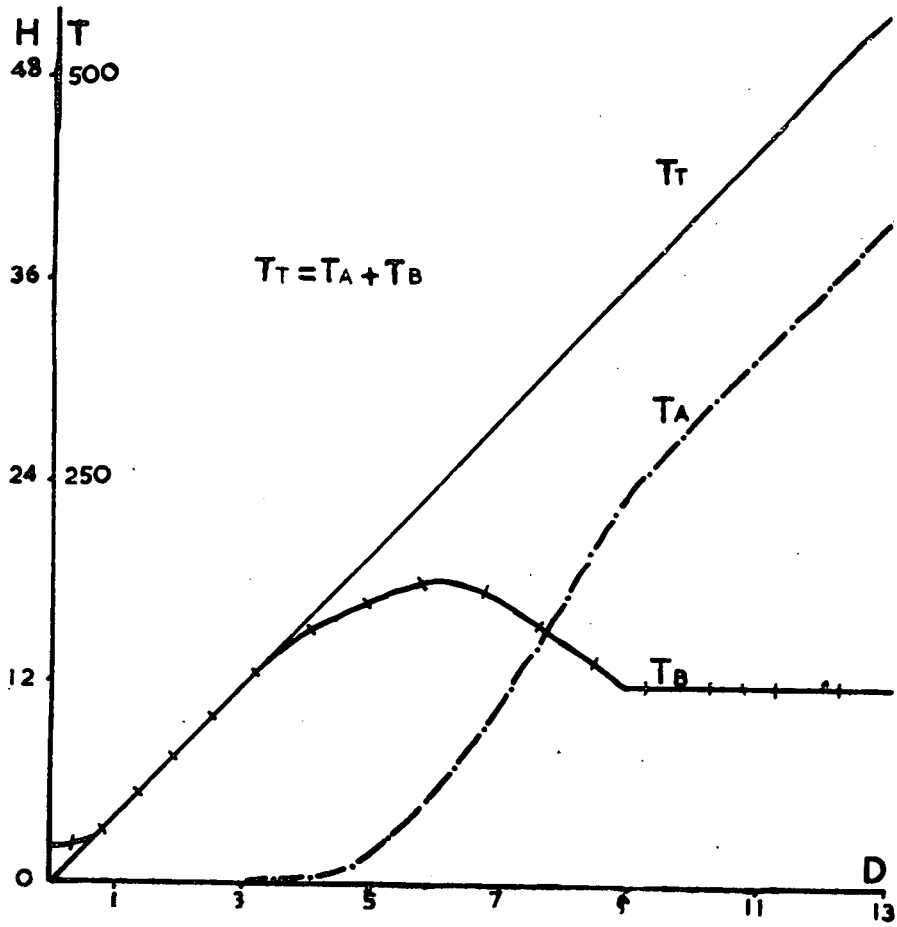

Figure 4 — Schematic relationship between stem diameter (D in mm at 2″ above ground level), plant height (H in inches) and production of above ground plant material (T in g/plant).

T_T — total weight of above ground plant material or plant height above ground level.

T_A — tipping weight

T_B — weight of plant material produced below tipping level of 12″.

Studies (Brouwer, 1962) of the distribution of dry matter over the various parts of a plant have shown that the removal of shoots may reduce the subsequent growth of the roots. This was confirmed for young tea plants by Visser (1962). Therefore, the percentage root losses might ultimately be as large as

those of the above ground plant parts shown in Fig. 5. It will be seen from Fig. 5, that percentage losses increase with increasing height up to a certain height, whereafter they decrease to a constant rate. For instance, losses incurred by plants having reached a height of 36″ and then tipped at 12″ would amount to approximately two thirds of all the leaves, branches and perhaps roots also, produced up to the time of tipping. Similar curves have been computed for plants tipped for the first time at levels of 8″, 10″ and 14″ respectively.

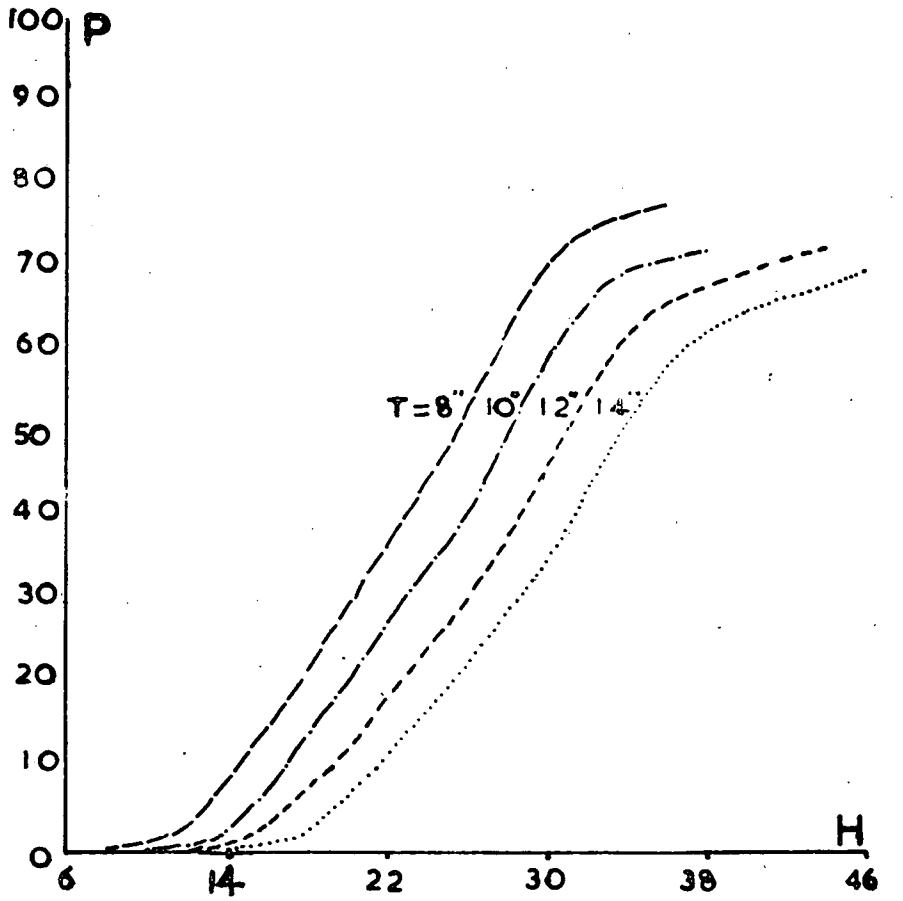

Figure 5*— Schematic relationship between percentage plant material removed (P in % of total weight of plant material produced at tipping) at different tipping levels (T) and height of plants (H in inches) at the time of tipping.

Though these finding need further confirmation both as such and for other clones and conditions, they may well serve as a guide when decisions have to be made on when to tip and on the choice of methods of bringing into bearing. It would seem obvious to draw the conclusion that any method that would reduce losses of plant parts of immature plants — other conditions being equal — would be worth consideration. This aim, *i.e.* to reduce losses of potentially productive plant material, would — other conditions being equal — seem to be easier achieved by bending than by tipping. Conditions, which might interfere in achieving this aim by bending, are the formation of less efficient frames, the absence of a possible growth stimulating effect from pruning (see Fig. 1) etc.

*Figure 5 is derived from Figure 4 and shows the schematic relationship between the height of the plant at tipping and the percentage of the total amount of plant material produced above the ground which is removed in the tippings. Thus, if plants, having reached a height of 19″, were tipped at 12″, about 20% by weight of the plant parts produced above the ground would be removed in the tippings.

The results showed that diameter measurements (*a*) might provide a useful growth index, (*b*) can be a helpful tool in attempts not only to assess the effect of cultural treatments on young plants but also to assess such effects (*c*) at an earlier stage and more reliably, than would be possible by means of future yield records.

1.2. *Fertilizer effects*

The six blocks of this trial are spread over different fields with different slopes and gradients and facing different directions, and are situated on tea land which was uprooted and rehabilitated with Guatemala grass during two years. The Guatemala grass was regularly lopped and manured with NPK mixtures at the recommended rates (Tolhurst and Portsmouth, 1956; Tolhurst, 1956). The experimental fertilizer dressings (one sixth of the annual dosage) were applied every two months since October 1962, *i.e.* 4 months after planting. At the time the December 1963 measurements were taken the plants were $1\frac{1}{2}$ years old and had received 7 applications, or in total: 0, 93, 186 or 279 lb N; 0, 47 or 94 lb P_2O_5 or/and 0, 58 or 116 lb K_2O p. acre. The experimental plots contained 36 plants with occasional supplies for dead plants, and were thatched in the beginning of 1963. Methods of fertilizer application were as recommended for young tea (Tolhurst, 1961).

The fertilizer effects were analysed by the Statistician and showed no significant differences in respect of stem-diameters taken at 2" above ground level in December 1963, nor in respect of number of leaves per plant (in February and April) and tipping weights (in June). Significant differences were however, obtained for the tipping weights recorded in October-December, the weights in the plots receiving 240 lb N being significantly lower than those receiving lower amounts of N (table 3). There was also a significant and negative NP interaction, which was mainly due to an adverse effect of N at the highest level of P (*i.e.* 80 lb P_2O_5 p.a.p.a.) At lower levels of P (viz. 0 and 40 lb P_2O_5 p.a.p.a.) tipping weights rose as the level of N rose and then fell as the level of N rose further to 240 lb.

TABLE 3.—*Tipping weights* (*October-December* 1963)

Main effects (in lb N p.a.p.a.)	Tipping weights (g per plot) (Mean of 18 plots)
N_1 (80)	4212
N_2 (160)	4198
N_3 (240)	3496
Sign. Diff. (5%)	514 (for N_1, N_2 and N_3 only).
No-fertilizer plots (mean of 6 plots)	3735

In the light of the results of table 3, it was of interest to note that the diameters measured at the collar (in December) differed at a level of significance of 7%, hence just short of a 5% level of significance (Fig. 6).

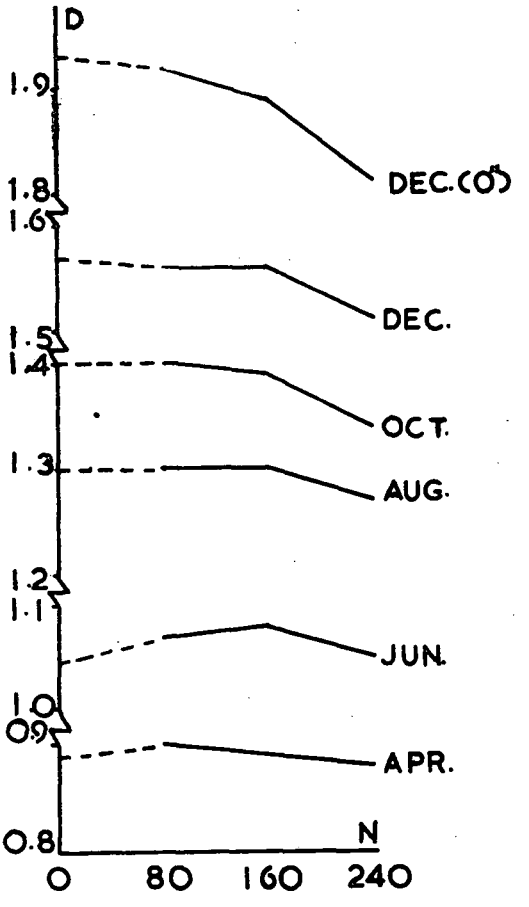

Figure 6 — The relation between N applications (N in lb/acre/annum) and stem diameter (D in cm) at 2" above ground level in April, June, August, October and December and at ground level in December (Dec. 0").

These results (table 3; Fig. 6) showed that excessive rates of N can have an adverse effect on growth as measured by tipping weights and diameter measurements. The difference in diameter between 80 lb N and 240 lb N plots amounted to approximately 6%. Working with rubber, cocoa and bananas the author found (Hasselo, 1961) that an increase in girth (expressed in %) generally corresponded with a two to three times larger percentage increase in yield. If this were valid for tea also, the observed 6% larger diameter in the 80 lb N plots, as compared with the 240 lb N plots would be equivalent to a difference in yielding capacity of between 12% and 18%. That such a two to three fold ratio might indeed be valid for tea was supported by the finding that the difference in tipping weights between 80 and 240 lb N plots was of the same order, the growth in the 240 lb N plots being retarded by 20% (table 3).

Furthermore, it will be seen from Fig. 6 that growth of plants receiving no fertilizers was on the average, better than in the plots receiving N, P or/and K fertilizers. A possible explanation would be that the availability of soil nutrients after two years rehabilitation was more than sufficient for a period of at least 1½ years after the tea was planted. If more degrees of freedom had been allocated to the no-fertilizer plots, as originally suggested, a more accurate assessment of optimal manuring rates could have been made. The results obtained under the conditions of the experiment showed that applications of 62

lb N per acre p.a. were more than enough in the first 1½ years after planting of upcountry fields rehabilitated during two years. As these results are the first of their kind in young clearings, lower rates of manuring than presently recommended (Tolhurst, 1961) might be well worth considering.

Finally, it was noteworthy that the number of plants that died up to date (about 4%, or, on average, 3 plants per 2 plots) was not significantly related to the different levels of P or K fertilizing, though at the lower levels of K there were on average ca. 50% more casualities than at the highest level of K. In respect of N, however, there appeared to be a significantly larger (P0.01) incidence of losses with increasing levels of N fertilizing (table 4).

TABLE 4.—*Plant losses (% of total)*

Main effects (lb N p.a.p.a.)	Losses (%)
80	2.3
160	4.0
240	6.0
chi-square	11.29
chi-square (P0.01)	9.21

It will be seen from table 4, that there were more than 2½ times as many losses in the 240 lb N as compared with the 80 lb N plots, or per 40 lb N applied extra, plant losses increased by 1%. Among the known or suspected causes for plant failure were drought, nematodes, Poria and Rosellinia disease. Consequently, the poorer growth in plots with higher N-levels can be attributed, directly, to a toxic effect of N and, indirectly, to reduced tolerance of a combination of adverse conditions, such as climate, diseases and pests.

These results demonstrate that under the experimental conditions large (extra)N dressings might have either no effect or a deleterious effect, even though growth and yield are progressing. They might serve as a warning against exaggerated expectations of large growth and yield responses, as a result of large dressings of nitrogen in young tea.

Conclusions

(*a*) Significant effects and interactions were obtained in a confounded NPK trial. The six blocks of this trial (each containing 10 plots of 36 plants each) were laid out in different fields and situated on different slopes with different gradients and facing different directions.

(*b*) Excessive amounts of nitrogen fertilizer, particularly in conjunction with high levels of P-fertilizing, retarded growth of young tea plants of TRI clone 2024 in the first 1½ years after planting and reduced their tolerance of adverse climatic conditions, pests and diseases.

(*c*) It is possible that a reduction of the fertiliser amounts, presently recommended for young tea in its first 1½ years after replanting is worth considering for upcountry areas, which have been rehabilitated with well-manured Guatemala grass for a period of 2 years.

(*d*) The inclusion of more no-fertilizer plots, alternatively the allocation of more degrees of freedom to control plots, was recommended when planning (alternatively designing) fertilizer experiments.

2. *Shade, fertilizer cum planting distance trial with two clones.*

Owing to nematode infestation in the nurseries (see Report of the Superintendent, St Coombs), no plants were available for planting this trial in 1963. It will now be laid out in 1964.

3. *Herbicide trial*

This trial could not be laid out for the same reason as mentioned sub 2. Its main objective is to test a possible after-effect of Simazine on growth and yield of tea. Provision has been made in the design to measure the effect of soil fertility and productivity on both weeds and tea plants.

C. Sand Culture Trial

Four months old plants of callused stage and of unifom size (cuttings of clone TRI 2024), were transplanted in pots (2 cuttings per pot) on 4th April. The pots contained sand obtained from the Ceylon Glass Co. Ltd. It was purified in accordance with the methods described by Hewitt (1952): it was "water-washed" to remove silt and clay, and treated with cold 3% hydrochloric acid for a week before leaching. Initially, it was leached with water and, subsequently, twice daily with the appropriate type of nutrient solution, until the leachate had the same pH value as that of the nutrient solutions (pH = 4.5) and showed no change in pH after remaining in contact with the sand for 24 hours.

The standard nutrient solutions adopted for use in this trial were based upon those recommended by Hewitt (1952) and are shown in table 5.

TABLE 5

Major elements	Milli equivalents per liter	Minor elements	m.e.qr. (or milli mols) per liter
NO_3^-	2.600	Fe^{++}	0.040
PO_4^{---}	0.800	Mn^{++}	0.004
SO_4^{--}	0.600	Cu^{++}	0.0004
Ca^{++}	1.734	Zn^{++}	0.0004
Mg^{++}	0.600	Al^{+++}	0.00002
K^+	0.866	B	0.0066 (Milli Mol)
Na^+	0.266	Mo	0.00004 ,,

When a cation was omitted from a nutrient solution, it was replaced by Na, in the case of an anion being omitted, it was replaced by SO_4.

The chemicals (analytically pure) used to make up the different nutrient solutions were: KNO_3; $Ca(NO_3)_2$ (anhydrous); NaH_2PO_4. $2H_2O$; $MgSO_4$. $7H_2O$; $NaNO_3$; Na_2SO_4. $10H_2O$; $CaSO_4$. $2H_2O$; Ferric citrate; SO_4. $10H_2O$ Mn SO_4. $4H_4O$; $CuSO_4$ $5H_2O$; Zn SO_4. $7H_2O$; H_3BO_3; $(NH_4)_6 Mo_7 O_{24}$. $4H_2O$ and $Al_2(SO_4)_3$.$12H_2O$.

Concentrated standard nutrient solutions were prepared in distilled water and were stocked in the dark in brown bottles. Aliquots were diluted (with tap water for the nutrient solutions deficient in the major elements and with distilled water for those deficient in the minor elements) for the nutrient solutions to be applied to the pots. Each nutrient solution was adjusted to pH 4.5 by the addition of sulphuric acid. Each pot containing two plants received at first 500 cc and later 250 cc of the nutrient solution once every two days.

There were seven treatments arranged in a latin square design: complete nutrition (= C), minus N, minus P, minus K, minus Ca, minus Mg, and minus Zn. These 49 pots were surrounded by one guard row containing 32 pots, subdivided in 8 groups of 4 pots. The nutrient solutions applied to these eight groups were deficient in Fe, Cu, B, Mn, Mo respectively or received double the amount of Mn or K or of the complete nutrition (= 2C). The minor element nutrient solutions were prepared in distilled water. The pots were kept in a glass house.

Results

Growth of the cuttings was generally poor to very poor, though distinct differences between the treatments were noted. Possible reasons for the poor growth were that (*a*) the pH of the sand in the pots had risen to about 7 by October, (*b*) the tap water contained rather large amounts of Fe (approx. 0.3 p.p.m. versus negligible amounts in the distilled water; these figures were 0.05 p.p.m. versus negligible respectively for Al.), and (*c*) the pH of the tap and distilled water was 7.4 and 6.8 respectively.

In order to reduce the pH of the sand in the pots, the pH of the nutrient solutions used was reduced from 4.5 to 4 and extra solutions (200 cc) of sulphuric acid (75 cc of 0.1 N diluted to 200 cc) were applied to the pots every other day since the beginning of December. By the end of the year the pH in the pots had been decreased to about 6.5.

Leaves (healthy and scorched) and plants with flowers or which had died were counted on 1.10 and 7.11.1963.

TABLE 6.—*Number of leaves (total and apparently healthy) per 14 plants growing in different nutrient solutions at two different dates*

Treatment (Nutrient solution prepared in tap water)	No. of leaves/14 plants			
	Total		Apparently healthy	
	1.10	7.11	1.10	7.11
Complete solution	60	26	21	5
Without N	64	36	45	22
,, P	55	50	27	26
,, K	38	20	9	2
,, Ca	18	17	4	7
,, Mg	52	53	23	24
S.D. at P0.05	30.6	27.4	18.2	16.5

(Nutrient solution prepared in distilled water except*)	No. of leaves/14 plants (figures per 14 plants computed on basis of 8 plants actually available)			
Without Fe	60	77	42	54
,, Cu	88	95	65	65
,, B	86	91	51	65
,, Mn	102	103	70	75
,, Mo	88	96	61	70
Excessive Mn	77	77	42	39
,, K*	75	79	42	39
double complete nutrition*	63	61	30	37
Without Zn	79	103	35	63
S.D. at P0.05	n.s.	n.s.	n.s.	n.s.

It would appear from table 6 that nutrient solutions deficient in Ca retarded growth considerably, whereas those deficient in N did not have such an effect or even had a favourable effect both on number of apparently healthy and total leaves. The adverse growing conditions became worse with time in the tap water treated pots, as would appear from the leaf counts on 1st October and 7th November.

If the poor growth performance of the plants were due to the high pH of the sand, it could not have been caused by a toxic effect of excessive Ca in the nutrient solution, owing to the unfavourable result obtained in the "without Ca" solution.

The growth of the plants treated with nutrient solutions prepared in distilled water was markedly better than those in tap water, the difference becoming more pronounced with time, *i.e.* in the period from 1.10 to 7.11. The use of tap water was apparently one of the main causes for the generally poor growing conditions. This was also borne out by the results shown in Table 7.

TABLE 7

Distribution of plants, dead (B) and alive (A), of number of apparently healthy (H) and scorched (S) leaves, of plants with (W) and without (O) flowers at different dates (1.10 and 7-11-1963) in a sand culture trial supplied with nutrient solutions prepared either in tap (T) or distilled (D) water.

	Number of plants											
	1.10			7.11			1.10			7.11		
	A	B	Total	A	B	Total	W	O	Total	W	O	Total
D	59	3	62	59	3	62	8	51	59	6	53	59
T	89	11	100	88	12	100	33	56	89	25	63	88
Total	148	14	162	147	15	162	41	107	148	31	116	147
Chi-square	1.8 (n.s.)			2.4 (n.s.)			9.7 (P0.001)			7.0 (P0.001)		

	Number of leaves								
	Scorched and apparently healthy leaves						Total		
	1.10			7.11			1.10	7.11	Total
	S	H	Total	S	H	Total			
D	134	249	383	139	290	429	383	429	812
T	191	175	366	153	130	283	366	283	649
Total	325	424	749	292	420	712	749	712	1,461
Chi-square	22.4 (P0.001)			33.1 (P0.001)			12.25 (P0.001)		

The real cause underlying the adverse effect of tapwater is not known, nor is it certain whether this cause would be operative also at lower pH values in the rooting medium. Further work is in progress in an attempt to elucidate these points.

Acknowledgement

The care given to this trial by my assistants W.B. Manipura and S.M. Kandasamy, is gratefully acknowledged.

D. Fertilizing Tea in Ceylon

Two articles were prepared on results of detailed studies made on the fertilizer polices adopted on tea estates in the low-, mid- and up-country of Ceylon. These studies have been helpful in the formulation of schemes for level of manuring of mature tea on tea estates in Ceylon. (See sub H below).

E. Foliar Analysis

This work is done under the "International co-operative Research Programme in Plant Nutrition" (see previous Annual Report, Hasselo, 1963).

Leaf samples are collected monthly in field trials at St Coombs and St Joachim estates situated in up- and low-country respectively. So far some 10,000 analyses have been made on leaf samples taken from a shade cum fertilizer trial at St Joachim. Mineral composition of leaves of 5 different physiological ages is determined for 13 elements: N, P, K, Ca, Mg, Mn, Fe, Cu, B, Zn, Mo, Al and Na, in consecutive months. The effects of and interactions between artificial shading (100% and 70% sunlight), fertilizer treatments and soil profile characteristics on leaf composition are investigated.

Results—St. Joachim Estate

(*a*) *Treatment effects*

Preliminary results show that in the relatively dry month of July (table 9) N—fertilizing had a significant effect on N and Ca content of the flush, while significant interactions between N fertilizing and shade were observed in respect of the flush N and P contents. In the rainy months of October and November 1962 shade had an effect on P, Ca and Mn content of the flush and K fertilizing on leaf P and Ca.

The mean nutrient contents of the flush of plants grown in full sunlight and under artificial screens (70% sunlight) are shown in table 8.

TABLE 8.—*Flush nutrient contents* (% *or p.p.m. dry matter*). *Mean of 5 monthly assessments* (*July-November* 1962) *in a shade cum fertiliser trial on St Joachim Estate.*

Sunlight	N(%)	P(%)	K(%)	Ca(%)	Mg(%)	Mn (p.p.m.)	B (p.p.m.)
100%	3.94	0.365	1.96	0.416	0.219	192	19.7
70%	3.87	0.352	1.94	0.386	0.217	155	16.4

Shading had a significant effect on leaf Mn. These preliminary results show that large variations in the mineral composition of tea leaves can occur under the influence of cultural treatments. Investigations are being continued and a more detailed account will be presented in due course.

(*b*) *Physiological age of the leaf*

The nutrient contents of tea leaves of increasing age decreased in respect of: N, P, K, Na and Zn but increased in respect of: Ca, Mn, Fe, B, Mo and Al. No clear age trends were apparent in respect of leaf Mg and Cu. Noteworthy

was the large decrease in leaf K from approximately 2% (on dry matter) in the flush to less than 1% in the maintenance foliage, and the marked increase in Ca from 0.4 to between 1.0 and 1.5%.

(*c*) *Monthly variations*

The mean flush contents of some of the major elements are shown in table 9.

TABLE 9—*Nutrient contents** (% *dry matter*) *of leaf flush in fertilizer trials at St Joachim Estate* (*Ceylon*) *and Tole Tea Estate* (*West Cameroon, West Africa*), *situated at* 2000 *feet above M.S.L.* (*see Hasselo*, 1961)

Month (St Joachim 1962)	Rainfall (inches)	N	P	K	Ca	Mg
July	8	4.26	0.384	1.92	0.391	0.218
August	12	3.97	0.377	2.02	0.394	0.221
September	15	3.75	0.375	2.10	0.421	0.228
October	18	3.62	0.348	1.97	0.392	0.212
November	14	3.77	0.325	1.90	0.426	0.220
Mean		3.87	0.362	1.98	0.405	0.220
(Tole)						
October	Wet	3.21	0.237	1.70	0.506	0.298
November	Wet & Dry	3.67	0.320	2.13	0.365	0.290
December	Dry	4.22	0.400	2.33	0.345	0.233

*Each figure represents the mean of 32 analyses made in composite samples taken in 32 differently treated plots.

It will be seen from table 9 that in Ceylon leaf N and P decreased whereas leaf Ca increased with increasing rainfall. Leaf K and Mg showed little variation. In the Cameroon, similar trends were found in respect of N, P and Ca, but, as distinct from Ceylon, leaf K decreased and leaf Mg increased with increasing rainfall. The figures for the dry month of December in the Cameroon and those of July in Ceylon are of the same order of magnitude though in Ceylon K and Mg would seem to be lower and Ca higher.

F. Soil - crop relationships

Investigations are continuing and, generally, confirm the results reported in the previous Annual Report (Hasselo, 1963).

G. Monthly variations of crop

The results of this study were published elsewhere (see sub H).

H. Publications

HASSELO, H. N. (1963). Report of the Chief Agronomist for 1962 *Rep. Tea Res.—Inst. Ceylon*: 47-50.

HASSELO, H. N. (1963). An evaluation of the monthly variations in yields of tea of two estates. *Tea Quart.* **34**: 111-119.

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TOLHURST, J. A. H. and PORTSMOUTH, G. B. (1956). Manuring Guatemala grass. *Tea Quart.* **27**: 45.

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REPORT OF THE LOW COUNTRY ADVISER FOR 1963

L. H. Fernando, Ph.D. (Lond.)

1. General

Low Country Station, St Joachim, Ratnapura.—Dr. A. W. R. Joachim Low Country Adviser was in charge of the Low Country Station of the Tea Research Institute of Ceylon at St Joachim, Ratnapura, at the beginning of 1963. Mr C. Andrews assumed duties as Superintendent of St Joachim Estate on the 7th of January 1963, and took over the estate from the management of Palmgarden Group. Dr L. H. Fernando assumed duties as Agronomist on the 1st of January 1963. Other staff on the Station consisted of a Chief Clerk, Stenographer and 3 Technical Assistants on the research section and a Head Clerk, Senior Assistant Clerk and Junior Assistant Clerk on the estate section. Dr A. W. R. Joachim assumed duties as Director of the Tea Research Institute of Ceylon, Talawakele on the 1st of March 1963, and Dr L. H. Fernando took charge of the Low Country Station.

Early in 1963 the construction of several buildings on St Joachim was started; at the end of 1963 one Senior, three Intermediate, ten Junior, and six Minor Staff bungalows, the Laboratory and the Factory were in various stages of construction.

Kottawa Sub-station.—Mr K. H. G. Gunapala continued as Officer-in-Charge of this Sub-station. While the development and planting of the first 25 acre block continued, an additional extent of 30 acres was taken over from Government and development work was started. A new potting shed was constructed in the nursery and an extension was made to the O.I.C.'s bungalow to shelter his car.

2. Advisory and Extension Activities

The number of reports and letters sent out during the year was 2,046, an excess of 331 over that of last year. In all 24 meetings were attended; these included meetings of the Low Country Station Committee, the Experimental and Estates Committee, District Planters' Associations, Committees for Nitrogen, Shade and Rehabilitation and the Senior Staff meetings at St Coombs. Estate visits were necessarily curtailed pending the appointment of an Advisory Officer to Ratnapura; the Advisory Division at St Coombs undertook most of the estate visits in the Low Country.

3. Research

3.1. *Manurial Experiment on Seedling Tea at Endane (Joachim, 1964).*—Nitrogen phosphorus, potassium and magnesium each at three levels were combined factorially in a 3^4 design, in three blocks of 27 plots each, replicated twice, making 162 plots in all. The three blocks in each replicate were used to compare the effects of Dieldrex and zinc versus none. The results are summarised in Table I.

TABLE 1.—*Endane Manurial Experiment—5th Cycle* (1961-63)

Yield of Crop (lb. made tea/acre)

Treatments lb/acre/year		Yields Acre/year lb.	%
	0	1249	100
N	40	1326	106
	80	1367	109
	20	1314	100
P_2O_5	40	1317	100
	60	1311	100
	40	1298	100
K_2O	60	1330	102
	80	1314	101
	0	1314	100
Mg	20	1312	100
	40	1317	100
Significant Difference at P = 0.05		44	3.5

Yield of Crop (lb. made tea/acre)

Treatments	1st Six Months		2nd Six Months		3rd Six Months		4th Six Months		Total Months	
	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%
Control	163	100	830	100	821	100	626	100	1220	100
Zinc Sulphate (37 lb/ac/cycle)	171	105	850	102	745	91	813	130	1290	106
Dieldrex (6 pints/cycle)	157	96	820	99	916	112	973	155	1433	117
Significant Difference at P= 0.05									128	10

Treatments showing significantly higher yield are underlined:

There are no significant differences in yields at the various levels of phosphorous, potassium and magnesium. Nitrogen, which in previous cycles has shown no significant effects, has now in the 5th cycle given significant increases in yield with both 40 and 80 lb. of nitrogen per acre per year. Plots which received no nitrogen in the last two cycles have yielded as much as 1,249 lb. per acre per annum. There has been a significant response to dieldrex spraying with an overall increase in yield of 17% over the two-year cycle. When the yield in each six-months period of this two-year cycle was examined, it was found that effect of dieldrex is evident only in the second year; in the last six-months of the two-year cycle the increase in yield with dieldrex is as much as 55%. These results clearly indicate that while the yield declined after eighteen months without dieldrex spraying, it continued to increase even in the last six months of the two-year cycle when dieldrex was sprayed. The 30% increase in yield obtained in the last six months of the two-year cycle in blocks treated with zinc sulphate shows that zinc—deficient tea late in the cycle can respond well to zinc sprays. The low response to zinc, only 6%, over the whole cycle is explained by the fact that the response to two sprays spanning tipping was

under observation and regular zinc spraying only started late in the cycle. The effect of nitrogen was greater with dieldrex than without it as shown in Table 2.

TABLE 2.—*Interaction between Nitrogen & Dieldrex spraying Yield (lb/acre/annum).*

	No Nitrogen	Nitrogen	Difference
No Dieldrex	1213	1277	64
Dieldrex	1333	1482	149
Difference	120	205	85
Significant Difference at P = 0.05			30

3.2 *Manurial Experiment on V.P. tea at Palmgarden (Joachim* 1964).—Nitrogen, phosphorus and potassium each at three levels, with three frequencies of application, were combined factorially in a 3^4 design, in 9 blocks of 9 plots each, making 81 plots in all, unreplicated. The first experimental cycle of this investigation was completed at the end of May 1963. The results are summarised in Table 3.

TABLE 3.—*Palmgarden Manurial Experiment* (1961-63)
Clone 2023

	lb/acre/annum	Yield of made tea lb/acre/annum	%
Nitrogen (N)	75	3124	100
	150	3340	107
	225	3448	110
Potash (K_2O)	50	3290	100
	100	3360	102
	150	3264	99
Magnesia (MgO)	0	3301	100
	24	3331	101
	48	3282	99
Frequency of application per cycle (times)	5	3232	100
	7	3287	102
	9	3392	105
Significant Difference at P = 0.05		104	3

Treatments showing significantly higher yields are underlined

Combination of level of Nitrogen (N) per acre per annum and Frequency of application (F) per cycle	Yield of made tea lb/acre/annum	%
N_{75} F_5	3066	100
N_{75} F_7	3072	100
N_{75} F_9	3238	105
$N_{150}F_5$	3318	108
$N_{150}F_7$	3346	109
$N_{150}F_9$	3346	109
$N_{225}F_5$	3306	108
$N_{225}F_7$	3443	112
$N_{225}F_9$	3596	117
Significant Difference at P = .05	200	6

Of the fertilizers applied only nitrogen showed significant differences in yield between the three levels applied. Fertiliser was most effective when it was applied 9 times per cycle and the highest yield was obtained when 450 lb of nitrogen (in the fertiliser mixture) was distributed in 9 applications per cycle. The yield obtained in the 1st, 2nd, 3rd and 4th six months period of the two-year cycle are shown in Table IV.

TABLE 4.—*Yield of made Tea for successive Six Months Period*

	Yield of made tea in lb. per acre
1st six months	526
2nd ,, ,, ...	1542
3rd ,, ,, ...	2252
4th ,, ,, ...	2297

3.3. *Zinc deficiency experiment on Seedling Tea at St Joachim (in collaboration with the Agricultural Chemistry Division).*—Zinc and nitrogen each at three levels and at three frequencies of application are combined factorially in a 3^3 design, unreplicated. Pre-treatment yields were recorded from October 1962 to April 1963 and on the basis of these yields 27 plots were selected for the experiment. These plots were pruned on 1st May 1963 and the following treatments were first applied on 1st July 1963:—

Zinc sulphate:	0,	20,	40	lb/acre/cycle of two years.
Nitrogen:	100,	250,	400	,, ,, ,, ,, ,, ,,
Frequency of application:	7,	9,	11	times per cycle, commencing

two months after pruning and thereafter 6, 8 and 10 applications according to the frequency, with the last application to be given two months before the end of the cycle. The plot yields up to the end of 1963 indicate a response to nitrogen; higher frequencies appear to be more effective with the higher levels of nitrogen. It has been observed previously that zinc deficiency symptoms are more pronounced at the end of the cycle.

3.4. *Shade Trial on V.P. tea at St Joachim.*—This experiment was conducted by the Plant Physiology Division and the full results would be reported by the Plant Physiologist.

3.5. *Statistical studies in field experiments at St Joachim.*—Pretreatment yields of plots are being analysed in consultation with the Statistician.

3.6.—*Investigations on pruning systems in V.P. tea at St Joachim.*—In this experiment a rest period of two months against none, combined with three methods of pruning, *viz.* rim-lung, centre-lung and cut-across, are being investigated in a randomised block design of 6 plots replicated 4 times. Pre-treatment yields of plots were recorded on 30 plots from May 1963 and of these only 24 are uniform enough for inclusion in the experiment. The experimental treatments will be given in May 1964.

3.7. *Effects and Interactions of Shade and Fertiliser on seedling tea at St Joachim.*—In this experiment, nitrogen, phosphorus and potassium, each at three levels, are combined factorially in a 3^3 design of 27 plots, in 3 blocks of 9 plots each, with an additional unfertilised plot, making 10 plots in all in each block. The three blocks will accommodate three shade treatments *viz.* no shade, Gliricidia at 14′ × 14′ and at 7′ × 7′. Three replicates will provide 90 plots in all. 122 plots were demarcated and pretreatment yields recorded with uniform shade and manuring from May 1963 and on the basis of these yields 90 plots will be selected for the experiment, which will commence after pruning in April 1964.

3.8. *Rehabilitation experiment at St Joachim. (In collaboration with the Agricultural Chemistry Division).*—8.1. The effects of Guatemala grass, Pueraria phaseoloides, and Guatemala grass with Pueraria on soil rehabilitation are being compared in three plots replicatied four times. Each plot is sub-divided into four sub-plots of 24′ × 20′ to accommodate two levels each of nitrogen and phosphorus combined as N_1P_1, N_2P_1. N_1P_2 and N_2P_2, N_1 and N_2 are 2 and 4 cwts. of Sulphate of Ammonia per acre per year respectively; P_1* and P_2* are 1 and 2 cwts. of saphos phosphte per acre per year respectively. All plots receive Muriate of Potash and Kieserite each at 1 cwt. per acre per year. The rehabilitation species were planted in October 1963. Gautemala appears to be the best ;the performance of Pueraria phaseoloides is very disappointing. The lower levels of nitrogen and phosphorus (N_1*P_1*) appeared to be adequate, there being very little difference between N_1P_1 and N_1P_2 plots in growth.

8.2. The effects of 15 species of legumes (listed below) on soil rehabilitation prior to replanting of tea are being compared in a randomised block. replicated three times, Each plot is 12′ × 10 . These legumes were planted in November 1963. All plots are being fertilised with 1 cwt. of sulphate of ammonia, 2 cwt. of saphos phosphate, 1 cwt. Muriate of Potash and 1 cwt of Kieserite per acre per year.

Legumes Planted

1. Pueraria javanica
2. Pueraria triloba
3. Crotalaria anagyroides
4. Crotalaria brownei
5. Pueraria thunbergiana (Kudzu)
6. Flemingia congesta
7. Tephrosia candida
8. Centrosema pubescens
9. Calapogonium mucunoides
10. Alysicarpus vaginalis
11. Dolichos lab-lab
12. Indigofera teysmanii
13. Stylosanthes gracilis
14. Desmodium ovalifolium
15. Pueraria phaseoloides

3.9. *A comparison of Vegetatively Propagated Clones at St Joachim in replicated plots (In collaboration with the Vegetative Propagation Officer).*—The following clones were established in nurseries in 1963 and will be planted out in experimental plots in May 1964:—

	Clone Numbers
Tea Research Institute ...	777 1114 1526 1530 2016 2020 2021 2022 2023 2024 2025 2026 2027 2039 2045 2046 2151 425 331
Balangoda	DG7, DG39, MT18, MT/BG.
Cannavarella	CV4/B1, CV5/B1, NK4/B29,MG3/B1
Carolina	CAR7/10
Coombewood	CW21
Craighead	CH13
Craig	CR2
Diyagama West	D, N, DG
Diyanilakele	DK1
Drayton	DT1
Endane	EN31
Gonamotava	GMT9

Hellbodde	...	H13/4
Kenilworth	...	KEN15/7, KEN16/3
Kirkoswald	...	K136 K150
Palmgarden (Karapincha)		KP204
Moray	...	MG
Mooloya	...	M21, M209
Nayabedde	...	N3
Neluwa ...	...	NL4/2
Passara	...	PA22, MPA1
Poronuwa	...	PO26
Poonagalla	...	PIG2, PUH5
Queenstown	...	QT1/5, QT4/4
Somerset (Radella) ...		E7/27
Talankande	...	TK48
Tangakelle	...	CY9
Thotalagalla	...	T5/35, T5/3
Tillicoultry	...	TC9
Uva Highlands	...	UH9/3
Wooton	...	W3
Downside	...	DW12
		Seed
Lansdowne	...	2026, 2023, 2023 × 2026
Rambukkande	...	2023 × 2026

3.10. *A comparison of Vegetatively Propagated Clones at Kottawa Sub-station (In collaboration with the Vegetative Propagation Officer).*—The following clones were planted at Kottawa in replicated plots:—

1961	1962	1963
1. CV5 B1	1. H6A1	1. DG
2. UH9/3	2. CH13	2. W3
3. CR4	3. 2016	3. 2021
4. 777	4. 2043	4. 2046
5. MT/BG	5. 2024	5. 2045
6. KEN16/3	6. D	6. ML7
7. PO26	7. MG	7. DT7
8. DG39	8. MPA1	8. DT43
9. 1024	9. H13/4	9. W/2 145
10. CY9	10. NK4 B29	10. DG3
11. EN31	11. 2022	11. TK2
12. 2025	12. N3	12. B275
13. 2023	13. MG3B1	13. 2024
14. T5/35	14. 2039	14. E7/27
15. K136	15. 2020	
16. DT1	16. KP204	
17. KEN15/7		
18. T5/3		
19. CV4B1		
20. 2026		
21. DT18		
22. 2027		
23. N		
24. 2151		
25. PA22		
26. Seed		
27. NL4/2		
28. QT1/5		
29. TK48		
30. NL3/1		
31. K150		

Plots are 28′ × 14′ in 1961 and 1962 and 28′ × 12′ in 1963. The design is a randomised block with four replicates, two replicates with Gliricidia shade and two without shade. In all experiments the plants are spaced 4′ × 2′. Of the clones planted in 1961, 2023 has given the highest yield. Other high yielders are 2026, T 5/35, UH 9/3, MT/BG, NL 3/1, BG 18, PO 26, DG 39, GMT 9 and PA 22. Yields were generally higher in plots without shade.

3.11. (*a*) *Spacing and Manuring experiments at Kottawa.*—11.1. Three clones (2024, 2016 and QT 4/4) planted in 1961 are compared at three spacings, 4′ × 1½′, 4′ × 2′, 4′ × 2½′) and at three levels of manuring in a 3^3 design of 27 plots unreplicated. In the first two years all plots received the same quantity of T.200 alternating with animal meal, and are now being manured at 100, 200 and 300 lb N/acre/annum, in eleven applications at intervals of two months, commencing two months after pruning and terminating two months before the end of the cycle. The spacing of 4′ × 1½′ has so far given the highest yield in each of the clones.

(*b*) Three clones (2023, 2026 and 18B) planted in 1962 are compared at 3 spacings (4′ × 14″, 4′ × 28″, 4′ × 42″) and at three levels of manuring in a 3^3 design of 27 plots unreplicated. Details of manuring are the same as in experiment 3.11. The spacing of 4′ × 42″ is obviously too wide; 4′ × 14″ does not appear too close at this stage.

3.12. *Manurial experiment with V.P. tea at Kottawa* (*In collaboration with Agricultural Chemistry Division*).—

Treatments N:	75	150	225	lb/acre/annum
P_2O_5:	0	30	60	,, ,, ,,
K_2O:	0	50	100	,, ,, ,,
MgO:	0	30	60	,, ,, ,,

Design —A3^4 factorial with 81 plots in nine blocks of nine plots each. An additional un-manured plot is provided in each block.

Planting was done with clone 2023 in August 1963.

Three forms of nitrogen *i.e.* sulphate of ammonia, hoof and horn and urea-formaldehyde are being tested for the tea in the early stages of growth by using one of these as the form of nitrogen in each block. Three of the nine blocks would thus be treated with each form of nitrogen.

Reference

JOACHIM, A. W. R. (1964). Manurial Trials in the Low-Country (Tea Research Institute Conference 1964.

REPORT OF THE ADVISER IN PLANT PROPAGATION FOR 1963

A. V. Richards, B.Sc., (Lond.), M.Sc. (Calif.), Dip. Agric. (Cantab.), A.I.C.T.A., (Trinidad)

1. General

1.1. *Staff.*—Mr. F. H. Kehl, Vegetative Propagation Officer left the Tea Research Institute on retirement on 13th December, 1963 to take up an assignment with an Agency House in South India.

Mr A. V. Richards assumed duties as Adviser in Plant Propagation on 1st October, 1963 and was responsible for the organisation and direction of all work on vegetative propagation selection and breeding of tea in the new Division of Plant Propagation.

Mr V. S. Kulasegeram, Research Assistant left for the United Kingdom on the 13th September, 1963 to start his post-graduate work at Wye College.

1.2. *Survey of V.P. tea in Ceylon.*—In order to ascertain the extent under V.P. tea in Ceylon, copies of a questionnaire were sent out to 826 estates having over 100 acres each in tea in November 1963, and of the 395 letters received in reply 277 gave information on clonal tea, which is as follows:—

Acreage under T.R.I. Clones

1. 2023	—	699 acres
2. 2024	—	1134 acres
3. 2025	—	314 acres
4. 2026	—	641 acres
5. 2027	—	14 acres
6. 2022	—	32 acres
7. 777	—	7 acres
8. Mixed TRI clones		749 acres
	Total	3590 acres
Acreage under other estate clones		2368 acres
Total acreage under clonal tea		5958 acres

Of the other estate clones the following are the popular ones:

MT 18, DG 39	—	Balangoda Group
CR 4	—	Craig
CH 13	—	Craighead
N	—	Diyagama
DT 1, DT 95	—	Drayton
KEN 16/3	—	Kenilworth Group
K 136, K 150, K 145		Kirkoswald Group
N 3	—	Nayabedde
NL 3/1, NL4/2	—	Neluwa
CY 9, WY	—	Tangakelle
UH 9/3	—	Uva Highlands

The following estates have over 100 acres clonal tea:—

Carolina Group (Lower Dickoya) — 161 acres
Enselwatte Group (Morawaka Korale) — 372 acres
Endane Estate (Ratnapura) — 247 acres
Galamuduna Group (Dolosbage) — 108 acres
Palmgarden Group (Ratnapura) — 270 acres
Pelawatte State Plantation (Kalutara) — 354 acres.

The acreage under clonal tea up to the end of November 1963, according to the figures supplied by the Tea Controller is 5996.

The following is a summarised report of Mr Kehl on the selection, propagation and testing of clones in 1963.

1.3. *Advisory.*—Altogether 136 letters were received and 178 sent out. Estate visits by all staff of the division numbered 140. Except for a few visits of an advisory nature, others were in connection with the three sub-stations and the Low-country station.

1.4. *Miscellaneous information on clonal selection.*

(i) *Hantane* (approximately 2500 ft). The total rainfall was 75.86 inches, and 193 wet days were recorded. One minor staff bungalow is being completed.

(ii) *Kottawa* (approximately 100 ft). 175.04 inches rainfall and 214 wet days were recorded. A sum of Rs. 3421.75 was realised on the sale of cuttings and green leaf.

(iii) *Passara* (approximately 3500 ft). The rainfall recorded was 96.98 inches, the number of wet days being 185.

2. Nursery Experiments

2.1. *Nursery testing of clones* (Hantane, Kottawa, Passara, St Coombs).

The third series of nursery tests which were started in 1962 were completed. The design used was similar to that described in the Annual Report for 1960 (Visser and Kehl 1961). On the results of the above tests, the following clones were selected to be planted in the 1963 clonal blocks.

1. B275 Ragalla	2. W 3 Wooton
3. W/2 145 Pitakanda	4. DG 3 Balangoda
5. DG 7 Balangoda	6. E 7/27 Somerset
7. ML 7 Mincing Lane	8. DG Diyagama
9. TGK 2 Tangakelle	10. 2021 St Coombs
11. 2046 St Coombs	12. 2024 St Coombs

2.2. 29 clones are being tested in the nurseries at the four stations for rooting at present, and sixteen of these will be selected for planting in the 1964 clonal blocks on completion of these tests.

2.3. *Effect of Ferric-Dimethyl-Dithio-Carbamate on the rooting of cuttings (St Coombs).*

Promising results were obtained in an experiment carried out by Mr V.S. Kulasegaram to determine the effect of "Fermate" dust (kindly supplied by Messrs Photo-Cinex, Colombo) on the rooting of internodal tea cuttings. Three concentrations consisting of 19%, 38%, 76%, of the active ingredient in

addition to the talc control were compared in the experiment. The cuttings were treated by dipping the bases in the powder and planted immediately. Each treatment was replicated 4 times. The cuttings were examined 7, 9, 11, 13 and 16 weeks after planting. The highest concentration of 76% was found to be the best.

Clone S. 106 which is a poor rooter gave rooting percentages of 7.5, 35.0, 62.5, 60.0 and 77.5 at 7, 9, 11, 13 and 16 weeks after planting with the 76% concentration in comparison to the control with talc which gave 0%, 0%, 0%, 2.5% and 0% rooting.

In view of the fact that such promising results have been obtained further trials with "Fermate" are to be laid out.

2.4. *Effect of the size of polythene bags on growth of cuttings (St Coombs and Kottawa)*

The following treatments were compared:—

1. $2\frac{1}{2}''$ diameter 8″ long
2. $3\frac{3}{4}''$,, 8″ ,,
3. 5″ ,, 8″ ,,
4. $2\frac{1}{2}''$,, 16″ ,,
5. $3\frac{3}{4}''$,, 16″ ,,
6. 5″ ,, 16″ ,,

Holes were punched in the lower 4″ of the 8″ bags and in the lower 8″ of the 16″ bags and the bags were filled with fumigated guatemala soil.

Two clones TRI 2023 and TRI 2024 were used, each clone being replicated four times. Assessments of root lengths and weights of top growths and roots were carried out at St Coombs 11 months after planting, and at Kottawa 9 months after planting.

While at both places the longest roots were found in the 16″ long bags of 5″ diameter, the top growth was as good if not better in the standard size 8″ long bags of 5″ diameter. There were no significant differences between the clones.

3. Clonal Testing Experiments (St Coombs, Hantane, Kottawa, Passara)

3.1. *St Coombs.*—The replicated plots planted in 1961 were brought into plucking in August 1963. Clones 2025, MT/BG, 2024, 2027, GMT 9, 2026 and KEN 16/3 appear to be the best yielders upto date.

Kottawa.—Plucking commenced in September, 1963.

Passara and Hantane.—The plots in these two stations will be brought into plucking early in 1964.

3.2. 1962 *Planting (Hantane, Kottawa, St Coombs and Passara).*—Clones planted in the replicated plots were given their first cut-across at 16″-18″.

3.3. 1963 *Planting (Hantane, Kottawa, St Coombs and Passara).*—The clones selected after nursery tests (see 2.1) were planted out in replicated plots.

Details of the various planting operations (1963) are given below.

	Hantane	*Kottawa*	*St Coombs*	*Passara*
Guatemala Planted	March 62	April 62	January 60	January 61
Guatemala cut at Ground level	May 63	May 63	February 63	August 63
Clones planted	July 63	May 63	June 63	October 63

Acknowledgements

Mr Kehl concludes:

As this is my last Annual Report, I take the opportunity of thanking my colleagues and planting friends for the inspiration and encouragement that has resulted from our close association.

4. Plant Breeding

Mr A.R. Sebastiampillai, Post-graduate Scholar in Plant Breeding carried out a survey of estates growing tea seed bearers on a commercial scale and found that there were about 23 estates with 1 to 22 acres in extent under seed bearers. Two of these estates were found to have TRI 2023 and TRI 2026 as biclonal seed bearers.

4.1. Observations on the morphological characters of the seedling progeny of both open pollinated and biclonal seed obtained from 8 estates were being made with a view to identifying jat characteristics.

4.2. The previous observations that tea is self incompatible were confirmed by results of self-pollination in clones TRI 1114 and TRI 777. Of the 100 self-pollinations made in each of the two clones only 1% fruit set was observed in clone TRI 1114 and none in TRI 777. The other clones TRI 2024, Ass 4/10 and DT 95 failed to set seed when self pollinated.

REPORT OF THE PLANT PHYSIOLOGIST FOR 1963

U. Pethiyagoda, B.Sc., Ph.D., D.I.C.

1. General

A shortage of staff marked the year under review. Mr A. R. M. Hassim went on transfer to the Low Country Station in April. Mr S. Nagarajah continued his studies abroad.

Mr H. B. Wijetunge joined the staff as a Technical Assistant on 1st July.

By the end of the year, arrangements had been completed for the recruitment of a Research Officer and another Technical Assistant.

I was appointed Plant Physiologist from 15th February. During this period I have functioned as the Convener/Secretary of the Experimental and Estates Committee and in a similar capacity on the "Nitrogen Committee". I was also one of the delegates representing the Institute at the Tenth Annual Scientific Conference of the United Planters Association of Southern India, held at Coonoor on the 11th September 1963.

75 letters have been sent out during the year and about 20 visits made to estates and sub-stations by members of the staff.

2. Artificial Shade experiments

2.1. *Shade experiment* (St Coombs).—This experiment, which has been previously described (Annual Reports for 1961 and 1962) came back into plucking in April 1963. Forty weekly pluckings were recorded.

In Table 1 are presented the yields calculated to 52 plucks.

TABLE 1.—*St Coombs artificial shade trial. Yields of crop for the period April-December 1963. Each figure represents the sum of four replicate plots (each plot = $19\frac{1}{2} \times 9\frac{1}{2}$ ft) and is expressed as dry weight in pounds and calculated to 52 plucks (from a total of 40 plucks.)*

Fertiliser Treatment	Light Intensity (as % Sunlight)			Mean
	100	60	40	
N_1K_1	21.08	21.28	19.85	20.74
N_1K_2	21.82	21.31	18.54	20.56
N_2K_1	25.15	24.63	19.42	23.07
N_2K_2	23.99	22.65	19.19	21.94
Mean	23.01	22.47	19.25	21.58

Significant Difference of Mean for shade treatments = 1.34 (at P=0.05)
Significant Difference of Mean for fertilizer treatments = 0.63 (at P=0.05).

Dry wt yield lb/4 plots/52 plucks

N_1	20.63	1.12 (P = 0.001)
N_2	22.51	
K_1	21.90	not significant
K_2	21.25	

These results obtained in the first nine months of the first complete pruning cycle for this experiment indicate that (*a*) the higher nitrogen level has significantly increased yield. (*b*) the densest level of shade has also significantly decreased yield. (*c*) at the higher level of nitrogen, there is some indication that the higher potash level has decreased yield. This is however not statistically significant.

In this experiment, samples of each pluck are drawn for an analysis of percentage banji. The results so far indicate that neither shade nor fertilizer has affected the growth status of the bushes.

2.2. *Shade experiment (St Joachim)*

This experiment has also been described earlier (Annual Reports 1961 and 1962). The pruning operation which was carried out in November 1962 was completed by the removal of lungs on 28-1-63. On each of these occasions, the assessments as described in the Annual Report for 1962, were carried out. In Table 2 are presented the results. Each figure represents the sum of the assessments made at the main prune and at removal of the lungs.

TABLE 2.—*St Joachim artificial shade trial. Assessments made at pruning (November 1962, Lungs removed January 1963). Each figure represents the mean of four plots and is the sum of the estimations at the main prune and at removal of lungs.*

(a) On the basis of shade treatments

	Light intensity (as % sunlight)		Sig. diff. at
	100	60	
Pruning weight (lb dry wt)	29.3	30.2	not significant
Wood weight (lb dry wt)	21.0	21.1	not significant
Leaf weight (lb dry wt)	8.3	9.1	not significant
Leaf number (estimated)	25,643	26,855	not significant
Leaf area (M^2-estimated)	51.7	58.4	5% level = 6.1

(b) On the basis of fertilizer treatments

	N_1K_1	N_1K_2	N_2K_1	N_2K_2
Pruning wt (lb dry wt)	28.5	29.5	30.4	30.3
Wood wt (lb dry wt)	20.3	20.9	21.7	21.3
Leaf wt (lb dry wt)	8.2	8.6	8.7	9.0
Leaf No. (estimated)	25,148	25,915	27,350	26,583
Leaf area (M^2 estimated)	52.7	52.9	56.9	57.6

	N_1	N_2	Sig. diff. at	K_1	K_2	Sig. diff. at
Total prunings	29.0	30.4	not significant	29.5	29.9	not significant]
Wood weight	20.6	21.5	not significant	21.0	21.1	not significant
Leaf weight	8.4	8.9	not significant	8.3	8.8	not significant
Leaf number	25,802	26,967	not significant	26,249	26,249	not significant
Leaf area	52.8	55.3	not significant	54.8	55.3	not significant

As far as shade is concerned therefore, only the estimated total leaf area has been just significantly affected. All other assessments appear unaffected.

The fertilizer treatments have been without effect on any of the assessments made. At St Coombs, the higher nitrogen level had very significantly increased the weights of pruning wood and leaf. The St Joachim trial has however shown neither fertilizer nor shade effects on the yields before pruning and on the assessments made at pruning.

The trial which came into plucking in the new cycle in April 1963, yielded 40 plucks during the year. Once again, the results indicate neither shade nor fertilizer effects (see Table 3).

TABLE 3.—*St Joachim artificial shade trial. Yield of crop for the period April-December 1963. Each figure represents the sum of four replicate plots (each plot = 19½ × 9½ ft) and is expressed as dry weight in pounds and calculated to 52 plucks (from a total of 40 plucks)*

Fertilizer treatment	Light Intensity (as % sunlight)		Mean
	100	70	
$N_1 K_1$	36.0	38.4	37.2
$N_1 K_2$	40.3	39.4	39.9
$N_2 K_1$	38.0	38.7	38.4
$N_2 K_2$	40.8	39.7	40.3
Mean	38.8	39.0	38.9

Dry wt. yield/4 plots/52 plucks

N_1	38.6	not significant
N_2	39.4	
K_1	37.8	not significant
K_2	40.1	

3. Mulch estimations under tea and shade trees (St Coombs)

This trial (described in the Annual Reports for 1961 and 1962) continued with monthly assessments of leaf litter. The results are presented in Table 4.

TABLE 4.—*Monthly assessments of mulch from shaded and unshaded tea.*
Shaded: Mean area per plot = 497 sq ft. Unshaded = 841 sq ft

Date	Unshaded			Shaded		
	lb FW/plot	lb DW/plot	Tons DW/acre	lb FW/plot	lb Dw/plot	Tone DW/acre
6-12-62	29.5	19.1	0.44	—	—	—
7-1-63	34.4	16.6	0.38	—	—	—
7-2-63	34.4	18.0	0.42	30.4	17.1	0.645
11-3-63	19.3	13.1	0.30	13.3	9.5	0.37
10-4-63	27.0	19.9	0.46	11.2	8.9	0.345
10-5-63	17.1	12.0	0.275	10.5	7.8	0.305
10-6-63	13.1	8.6	0.20	10.8	7.5	0.29
Total			2.475			1.955
Mean			0.354			0.391

At the time of pruning these plots in June/July, the leaf carried by the bushes was stripped and the fresh and dry weight recorded. When expressed as tons of dry matter per acre, the mean values obtained were: Shaded plots = 2.56; Unshaded plots = 2.04.

These values amount to approximately 5-7 times the mean monthly additions of litter in the period immediately preceding pruning. If this were interpreted to mean that the average life span of a leaf at this stage in the cycle is 5-7 months, then it would seem that the leaves produced towards the end of a cycle have a longevity much less than those produced at the start of the cycle. Thus for the first eight months of the new cycle, the leaf dropped by the bushes has been quite negligible. Admittedly much of the leaf now carried by the bushes is considerably less than eight months old. It would be interesting to know whether the rate of leaf dropping will undergo any marked change once the canopy of tea closes over.

4. Growth of Guatemala and Mana grasses

This trial being conducted at five elevations and briefly described in the Annual Report for 1962 has furnished the following results so far. (Table 5).

TABLE 5.—*Record of loppings obtained from Mana and Guatemala grasses. The results are expressed as fresh weights of loppings. Each figure represents the sum of two plots, each carrying 96 plants at a planting distance of 2 ft × 2 ft*

Location	Grass	Planted on	1st lopping	2nd lopping	3rd lopping	4th lopping	Total
Kottawa (200 ft)	Mana	16-10-62	34 lb (21-2-63)	313 lb (2-5-63)	461 lb (30-7-63)	1206 lb (30-9-63)	51.0 tons/ac.
	G'mala		25 lb	203 lb	608 lb	1021 lb	47.0 tons/ac.
Passara (3,400 ft)	Mana	5-11-62	35 lb (10-6-63)	448 lb (4-12-63)	—	—	12.2 tons/ac.
	G'mala		68 lb	451 lb	—	—	13.1 tons/ac.
Hantane (2,500 ft)	Mana	9-11-62	280 lb (19-7-63)	395 lb (20-11-63)	—	—	17.1 tons/ac.
	G'mala		300 lb	443 lb	—	—	18.8 tons/ac.
St Coombs (4,500 ft)	Mana	31-12-62	282 lb (20-9-63)	256 lb (31-1-64)	—	—	13.6 tons/ac.
	G'mala		594 lb	716 lb	—	—	33.1 tons/ac.

At Oliphant Estate, the plots were damaged before the grass could furnish any loppings.

Three of these trials have been laid down on former jungle land and their remoteness makes efficient supervision difficult. For this reason it is intended not to plant tea at these locations as earlier planned. This trial will therefore be concluded at a suitable stage.

The results so far obtained are interesting in the way that very different growth rates at the various locations (as indicated by lopping dates and returns of loppings) are reflected. The relative performances of the two grasses at Kottawa and St Coombs are also striking.

5. Carbohydrate reserves in tea roots

The level of starch reserves as regulated by elevation and cultural practices (particularly pruning) have been under study for some time (Annual Reports for 1961 and 1962). With the occasional reports of poor recovery, casualties and dieback after pruning the question of the role of reserves in sustaining the early growth of pruned bushes is assuming increasing importance. In particular, the possibility of high cropping levels — whether with high-yielding

clones, heavy manuring or other factors — leading to depletion of reserves to dangerously low levels, warrants examination. All such investigations require reliable methods of sampling and estimation, and probably a study of compounds besides starch, which could serve as sources of "available carbohydrate".

In some of our studies on starch reserves of roots, marked inconsistencies have appeared in the results. This has prompted us to scrutinise the sampling and estimation techniques.

(*a*) *Sampling method.*—The practice adopted hitherto has been as follows:— on each sampling occasion, a single piece of root of 3/8th inch diameter and of a length of 2-4 inches is removed from each of five bushes selected at random. The root segments are cut up on a circular saw and the sawdust mixed well in equal amounts to form a composite sample which is dried at 80°C and stored in sealed polythene bags until used for estimation of starch. The bushes sampled are marked and avoided on subsequent sampling occasions in case the removal of the root has resulted in any alteration in carbohydrate status.

We set out to determine (*a*) whether there were large variations from bush to bush and whether five bushes were adequate as a reliable sample; (*b*) whether different but similar sized roots of the same bush had variable starch contents and (*c*) whether meticulous adherence to a particular size of root was necessary.

In Table 6 are presented the starch contents of seven standard-sized (3/8th" diameter) root samples from each of eight bushes selected at random. As far as known these bushes were identical in regard to age and the various cultural operations carried out on them. They were from a seedling field but the selected bushes were generally similar in appearance. Each figure represents the mean of duplicate samples and is expressed as percentage of dextrose, based on the initial dry weight of the sample.

TABLE 6.—*Starch contents of seven different, standard sized* (3/8" *diameter*) *root samples from each of eight different bushes. The root numbers are arbitrarily assigned. Results as per cent dextrose based on initial dry weight*

Bush Number	Root Number							Mean
	1	2	3	4	5	6	7	
1	11.1	11.4	15.6	5.2	14.2	19.2	15.9	13.2
2	26.7	36.6	30.0	19.5	35.8	30.6	34.8	30.6
3	23.8	13.6	12.9	8.1	12.6	10.6	10.6	13.2
4	8.1	6.1	6.1	11·9	15.3	12.6	6.9	9.6
5	30.8	15.3	19.5	28.4	32.4	16.1	22.2	23.5
6	6.9	20.6	14.0	6.9	8.6	6.9	9.9	10.5
7	5.5	3.1	0.8	9.4	8.6	5.5	12.6	6.5
8	30.0	11.9	18.8	12.6	24.8	19.1	13.3	18.6
Mean	17.8	14.8	14.7	12.8	19.0	15.1	15.8	15.7

The differences between bushes are significant (at $P=0.001 = 10.56$) The differences between roots of the same bush are not significant. The results thus indicate that while similar sized roots of the same bush have relatively constant amounts of starch, the variation from bush to bush is very large. In the population sampled for this assay, the mean values for starch content range from about 7-31% — a difference of over 300%.

Within the limits of this population, it was of interest to determine the minimum efficient sample size. When the values obtained for individual roots were analysed, it appears that with 5 bushes, the coefficient of variability just falls below 10%. From this it would seem that the use of single samples from

five bushes to yield one composite sample might have yielded a satisfactory estimate of root starch. However, the large individual variations from bush to bush would seem to make it necessary for the same five bushes to be sampled from occasion to occasion when time or treatment trends in starch contents are under study.

When a similar analysis was done using the mean values based on the seven replicate root samples for each bush, the minimum efficient sample was seen to be constituted by 4 bushes. In view of the very small variation between roots of the same bush, it is not surprising that the refinement of using several samples from the same bush does not result in a worthwhile reduction in the sample size required.

The data in Table 6 indicated the wide inherent variation in root starch contents of seedling bushes which on the basis of their age and management would have been presumed to be similar. Root samples were also obtained from some plots intended for a simple pruning trial on Clone TRI 2024 at Queenstown Estate, Hali-Ela, at about 3000 feet in the Uva District. Single root samples were drawn from ten bushes from each of three plots intended for the trial — before the pruning treatments had themselves been imposed. The figures in Table 7 illustrate the relative uniformity of starch contents in the roots of a clonal population — contrasting with the large range encountered with the seedling bushes (Table 6).

TABLE 7.—*Starch contents of 30 bushes of TRI 2024 from Queenstown Estate, Hali-Ela. Ten bushes were selected at random from each of three plots. Samples were taken before any experimental treatments were imposed. Starch is expressed as per cent dextrose based on the initial dry weight of sample*

Plant No.	Plot No.			Mean
	1	2	3	
1	7.9	7.9	11.7	9.2
2	5.1	11.3	8.3	8.2
3	5.9	5.9	5.9	5.9
4	6.3	20.9	5.5	10.9
5	14.9	7.9	13.5	12.1
6	20.3	10.4	8.3	13.0
7	11.7	15.9	9.9	12.5
8	10.4	16.7	10.8	12.6
9	10.8	9.5	4.4	8.2
10	7.3	21.3	8.3	12.1
Mean	10.1	12.7	8.7	10.5

Mean = 10.5 ± 4.6

Neither the differences between plot numbers nor plant numbers is significant.

In order to study the importance of root size in relation to starch contents, four main roots were removed from each of three similar seedling bushes. Each root was cut into six size categories based on root diameter. The samples were separately analysed for starch contents. The results are presented in Table 8. Each figure represents the mean starch content for the four separate roots of the same size and from the same bush.

TABLE 8.—*Starch contents of different sized roots. Four roots were sampled from each of three bushes. Each value represents the mean of four samples of the same size and from the same bush, analysed separately. Starch expressed as per cent dextrose based on initial dry weight of sample*

Plant number	Diameter of root samples in cm.						Mean
	2.5–3.5	2.0–2.5	1.5–2.0	1.0–1.5	0.5–1.0	less than 0.5	
1	20.9	20.0	16.0	14.9	15.7	13.0	16.7
2	32.0	28.1	26.4	27.1	13.5	13.2	23.4
3	17.7	20.1	13.7	10.3	6.8	5.3	12.3
Mean	23.5	22.8	18.7	17.4	12.0	10.4	17.5

(l.s.d. at 5% level for root size = 4.96)

The results indicate a progressive increase in starch contents as the size of root sampled is increased. Although information is lacking on which particular regions of the root best reflect fluctuations of starch content, the adherence hitherto to a particular small size of root (0.95 cm diameter *i.e.* 3/8 inch) seems justifiable. This point will be further studied with a view to determining the most satisfactory sampling zone.

A feature of considerable interest that we encountered in these studies was the very consistent values obtained for starch contents of "feeding roots". With the relatively little damage that is probably inflicted on a bush by sampling a small quantity of feeding roots, this would constitute a very satisfactory type of tissue for successive sampling of a bush. However, analyses carried out on five bushes selected from each of eight fields at St Coombs at varying ages from pruning indicated that the starch contents remained very similar and did not reflect any effect of pruning age. The results are summarised in Table 9.

TABLE 9.—*Starch contents of "feeding roots" from bushes at varying ages from pruning. The results are expressed as per cent dextrose based on initial dry weight of sample.*

Bush Number	Age From Pruning — in months								Mean
	1	4	15	15	23	25	38	39	
1	6.9	6.9	6.3	5.5	7.9	4.4	6.3	7.3	6.4
2	2.3	4.9	6.7	5.1	6.3	6.7	6.7	6.7	5.7
3	5.5	0.8	5.9	7.9	5.5	6.7	6.3	5.9	5.6
4	11.9	8.1	7.3	7.3	5.5	6.7	8.7	6.7	7.7
5	9.4	6.1	7.3	7.3	6.3	5.1	5.5	5.1	6.5
Mean	7.2	5.4	6.7	6.6	6.3	5.9	6.7	6.3	6.4

The apparent constancy of starch contents of feeding roots clearly make them unsatisfactory as indicators of the carbohydrate status of bushes. That such actively growing organs are not stores of immobile storage materials like starch is not a matter for surprise. It is felt that estimations of soluble carbohydrates in feeding roots may be more rewarding and this matter is also to be studied.

The results of the investigations into sampling methods for the estimation of starch reserves in tea roots, may be summarised as follows:—

(i) There is a wide variation in root starch contents between seedling bushes that have been identically treated.

(ii) Within the same bush, different standard-sized roots have similar starch contents.

(iii) There is a relationship between the diameter of a root and its starch content.

The practice hitherto of bulking five single standard-sized roots selected from five bushes to yield a composite sample seems satisfactory. In view of the wide bush-to-bush variation, it would be a wise precaution to sample the same five bushes repetitively when a time or treatment trend is under study. Information needs to be sought on the possible effects of successive removals of root segments from the same bush. A clonal population examined showed less variation from bush to bush. It would seem profitable to also examine levels of other carbohydrate components in addition to starch, perhaps "total carbohydrate", soluble sugars etc. This may be particularly relevant in the case of feeding roots whose starch contents have proved to be markedly uniform.

It also remains to be seen whether the above general conclusions — based on studies of bushes growing at high elevations — will be equally valid for populations at lower elevations.

(*b*) *Estimation method.*—The broad outline of the method for the estimation of starch is as follows:—A sample of dried root powder is freed of soluble sugars and certain coloured impurities by extraction with methyl alcohol in a soxhlet extraction apparatus. Starch in the residue is hydrolysed enzymatically. The solution containing the hydrolytic products is further subjected to boiling with hydrochloric acid to complete the hydrolysis to simple sugars. An aliquot is used to reduce the Somogyi reagent and the precipitated copper oxide estimated colorimetrically by the addition of Nelson's reagent. The results are expressed as per cent dextrose based on the initial dry weight of sample.

In earlier studies, enzymolysis had been carried out by the addition of appropriate amounts of saliva. It was found that on certain occasions, only partial hydrolysis of starch could be attained by this method. The use of commercial "taka-diastase" consistently yielded higher estimates of starch than were obtained by the action of saliva on identical samples.

It turned out however, that along with the presumably more efficient hydrolysis obtained with the commercial enzyme, it was also the source of a considerable amount of reducing power. Consequently, in all estimations carried out using this enzyme preparation, estimates of starch are corrected by a suitable deduction for the reducing power arising from the enzyme itself. Such corrected values are presented in the foregoing tables.

In view of certain doubts which still exist in regard to the adequacy of the estimation method and which are under investigation, the figures in these tables are presented with the emphasis on the relative rather than the absolute values.

6. Observations on production of "banji" shoots in tea

Studies of past records available in the Division and routine analysis of samples of plucks drawn from various trials and the different fields of St Coombs have indicated the following general features in respect of this phenomenon:—

(i) Shoots allowed to grow freely, illustrate a cyclic alternation of phases of apical dormancy (banji) and active growth. All the shoots of a given bush are not synchronous in their growth rhythm.

(ii) In the case of bushes in plucking, the percentage of plucked shoots in the banji condition increases as the cycle advances. Thus increase appears most marked in the first year of plucking.

(iii) Banji percentages show a marked pattern of fluctuation with time. The peaks and troughs are strikingly similar for successive years of the pruning cycle. The amplitudes of variation are smaller in the first year than in succeeding ones.

External factors alone do not account adequately for the observed periodicity. Age from pruning and certain inherent characteristics like jat, clone etc. would also seem to influence the pattern.

There is no consistent correlation between banji percentage and yield.

Observations on samples from the St Coombs Shade Trial (2.1) have revealed no marked shade or manurial effects.

7. Pruning trials

(*a*) *Comparison between the effects of five types of pruning.*

This trial was laid down on old seedling tea in the fourth year of a pruning cycle, (No 12 Field, St Coombs).

Six pruning treatments were replicated five times. The replicates for each treatment were within the same row up and down the slope, for ease of management. Each plot consists of 25 bushes. Pre-plucks for all rounds were recorded on a plot basis.

The pruning treatments were:—

(*a*) Unpruned control
(*b*) Cleanpruned
(*c*) High cut-across
(*d*) Longitudinal half-prune
(*e*) Annular half-prune (peripheral prune) and
(*f*) Lower leaves below plucking table stripped.

Yield and banji percentages are being recorded.

(*b*) *Observations on recovery from pruning*—A small scale trial on TRI 2024 is in progress for observations on bud-break and recovery from three types of pruning treatment. (No 10 Field, St Coombs).

(*a*) Clean prune
(*b*) Rim-lung (4-6 lungs) and
(*c*) Longitudinal half-prune.

A comparable block was rested for three months prior to pruning.

Counts of growing buds were made at time of removal of the unpruned portions of treatments (*b*) and (*c*) and at tipping of the earlier pruned parts.

Observations indicate that clean pruning results in a greater amount of bud-break, but the retention of unpruned branches hastens the growth of the buds once they have begun. Resting although it advances bud-break, does not reflect its beneficial effect in tipping weights. A larger scale trial along similar lines, on seedling tea and TRI 2025 has also been commenced at St Coombs.

A further pruning trial being carried out at Passara Sub-station in conjunction with the District Advisory Officer, Uva is described in the latter's Annual Report (Report of the District Advisory Officer, Uva).

8. Miscellaneous

(*a*) *Rooting of successive nodal cuttings*—A study was carried out in collaboration with the Plant Propagation Division on the rooting and early growth of five successive nodal cuttings from clones TRI 2023, 2024, 2039,25 and 1114. Assessments of percentage rooting and fresh and dry weights of top and root growth were done at 7, 14 and 21 weeks. At each assessment two replicates, each of 20 cuttings were used from each treatment.

The results failed to reveal any consistent influence of leaf position on any of the above measures of growth.

Publication

PETHIYAGODA, U. AND SHANMUGANATHAN, N. (1963). Notes on a visit to the 10th Annual Scientific Conference of UPASI. Tea Quarterly 34 (4): 172-178.

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ANNUAL REPORT OF THE CHIEF ADVISORY OFFICER FOR 1963

C. B. Foster-Barham, M.A.

1. Correspondence and Visits

During the course of the year, some 2,300 letters were despatched in answer to enquiries received from all sources. This was about 170 more letters than in 1962, and involved some 460 estates or about 45% of the estates listed in the 1963 Ferguson's Directory. The percentage of estates which corresponded remained approximately the same as in 1962.

203 visits were made to estates, inclusive of 50 visits made by the District Advisory service at Passara.

Other Divisions of the Institute have dealt with special correspondence and have made estate visits in connection with their own particular lines of research which are not included in this report.

2. District Advisory Service, Uva Province

The establishment of a District Advisory Service at the T.R.I. Sub-station, Debedde, Passara, in August of this year, marked the first stage in the expansion of the sphere of activities of the Advisory Division outside St Coombs upon which, apart from the Low Country service previously in existence, they have been centred since November 1959. Mr L. M. de W. Tillekeratne was appointed District Advisory Officer for the Uva Province and also Officer-in-Charge of the Sub-station, and took up his duties at Passara on the 1st of August. His report is given separately.

3. Staff matters

3.1. The Chief Advisory Officer proceeded on overseas leave on 6th August, returning on 12th October. During this period Mr D. T. Wettasinghe took over as Officer-in-Charge until September, when Mr J. V. Sabanayagam replaced him till 12th October.

3.2. Mr D. T. Wettasinghe left Ceylon in September for a period of postgraduate training under a Colombo plan scholarship in England. His studies are being directed in the specialized field of weed-control at Reading University and also in Oxford.

3.3. Mr R. K. Nathaniel was appointed Research Assistant in the Advisory Division, and took up his duties on the 4th of November.

3.4. Mr K. L. de Alwis was appointed Filing Clerk and took up his duties on the 1st of July.

4. Soil and plant specimens from estates

4.1. 538 soil samples were examined for pH during the year, an increase of 64 over last year. A large number of these were also examined for texture, and in fact most estates sent soil samples in connection with suitability of use

in nurseries, while rather less in number had pH examinations carried out with regard to determining causes of unsatisfactory growth. The number of soil samples examined, although more than in 1962, remained relatively few on account of by far the larger proportion of soil samples being sent to Colombo Firms who also carry out analyses for eelworm at the same time.

4.2. Cases of all types of pest and disease and of other conditions found in plant specimens of various kinds examined in the Advisory Division laboratory at St Coombs and also during estate visits from St Coombs by advisory staff, totalled 980. Amongst these there were 153 cases in which the actual cause or causes of unsatisfactory growth or of death, or the identification of the cause of particular symptoms, could not be precisely determined or were actually unknown, while a further 66 cases involved specimens which arrived at the laboratory in unsuitable condition for diagnosis, these being due most frequently to incorrect packing, or to having remained so long in the field before being sent for examination that all trace of original or primary cause has disappeared.

5. *Note.*—In the report on diseases, pests, *etc.* which follows, enquiries from the Uva Province are included up to 31st July, and the remaining enquiries follow in the District Advisory Officer's report covering the remainder of the year for Uva.

6. Fungal Diseases

6.1. *Poria hypolateritia.*—(Red Root Disease).

60 cases of this disease amongst 49 estates in 25 districts were reported, the number of cases in each particular district being as follows: Galle (1), Ramboda (3), Morawak Korale (2), Hewaheta Lower (2), Dickoya (9), Dickoya Lower (1), Kotmale (2), Dimbula (12), Matale East (1), Pussellawa (3), Pundaluoya (2), Maskeliya (3), Kalutara (1), Passara (1), Dolosbage (4), Udapussellawa (1), Badulla (1), Haputale (1), Rangala (1), Madulsima (1), Nuwara Eliya (1), Kelani Valley (1) and Ratnapura (1).

There were also 24 general enquiries from 18 estates in 9 different districts. 15 of these estates made enquiries in connection with fumigation against Poria.

6.2. *Rosellinia arcuata.*—(Black Root Disease).

35 cases of this disease were reported amongst 27 estates in 13 districts, the number of cases in each of these districts being as follows. Nuwara Eliya (3) Badulla (5), Haputale (11), Haputale West (2), Udapussellawa (2), Dimbula (4), Hantane (1), Maturata (1), Passara (1), Dickoya (3), Maskeliya (1), Madulsima (1) and Balangoda (1).

6.3. *Rosellinia bunoides.*—(Black Root Disease).

The presence of this particular species of Rosellinia which is generally rare amongst tea in Ceylon, was recorded on two occasions on one estate in Dimbula district.

6.4. *Ustulina deusta.*—(or *Zonata*) (Charcoal Root Disease).

24 reported cases of this disease were reported amongst 19 estates in 11 districts as follows: Dimbula (4), Haputale (6), Haputale West (1), Hewaheta Upper (1), Udapussellawa (2), Dickoya (1), Ramboda (2), Passara (3), Badulla (1), Galle (1) and Pussellawa (1).

6.5. *Fomes noxius.*—(Brown Root Disease).

There were 11 reported cases of this disease amongst 8 estates in 6 districts, the number of cases occurring in each district being as follows: Kelani Valley (1), Badulla (2), Udapussellawa (4), Kegalle (2), Galle (1), and Dimbula (1).

6.6. *Fomes Lignosus* (White Root Disease).

The occurrence of this disease was reported on 4 estates amongst Galle, Morawak Korale, Kelani Valley and Ratnapura districts.

6.7. *Macrophoma Theicola* (Stem canker) was reported from 4 estates in Nuwara Eliya, Haputale (2 estates) and Madulsima districts.

6.8. *Leptothyrium theae* (Branch and Collar Canker) was reported from 5 estates in Nuwara Eliya (two cases on one estate), Badulla, Udapusselawa, Haputale and Balangoda districts.

In addition to these reported cases, 12 estates made general enquiries in regard to control and the likelihood of the disease spreading to or having been actually previously recorded in their particular areas.

6.9. *Rhizoctonia solani* (Black Blight disease).

10 estates in 6 districts, namely Galle, Morawak Korale, Matara and Weligama, Kalutara, Dolosbage and Kelani Valley, were found to have this disease present, and number of experiments in connection with the maintenance leaf-fall problem, with which this disease is associated, have been in progress, and a leaflet dealing with this problem has been published.

6.10. Amongst specimens sent by estates to the laboratory and cases diagnosed in the field, the following fungal diseases attacking tea were also recorded.

Disease	*No. of cases*	*No. of estates*	*District*
Red Rust (Cephaleuros sp)	18	16	Galle, Rakwana, Kalutara, Kelani Valley, Balangoda.
Horse-hair Blight (Marasmius equicrinis)	7	6	Galle, Ratnapura, Matale South and Rakwana.
Thorny Stem Blight (Aglaospora aculata)	5	5	Dimbulla, Haputale, Badulla, Rakwana and Udapussellawa
Violet Root Rot (Sphaerostilbe repens)	5	5	Dickoya, Ratnapura and Dimbula
Diplodia Root Rot (Botryodiplodia theobromae)	1	1	Udapussellawa
Septobasidium	1	1	Galle
Fusarium sp.	1	1	Ratnapura

7. Deficiencies in Chemical Nutrients

7.1. *Zinc.*—During the year this deficiency was recorded on 44 estates which either sent specimens for examination or were visited. The number of estates in the districts concerned was as follows:—

Pussellawa (5), Dimbula (9), Dickoya (4) Dickoya Lower (2) Haputale (1), Galle (6), Kotmale (2), Badulla (1), Matara (1), Ratnapura (1), Balangoda (2), Rakwana (1), Kalutara (1), New Galway (1), Maskeliya (1), Lunugala (1), Kelani Valley (1), Nilambe (1), Kegalle (1), Kelebokka (1), and Hantane (1).

There were also 51 general enquiries on this subject.

7.2. *Magnesium.*—Deficiency of this chemical nutrient was recorded on 35 estates in 22 districts during the course of the year, and 45 general enquiries in addition were received on this subject alone. The districts and the number of estates in each, from which symptoms were recorded either in specimens sent to the laboratory, or were identified in the field, were as follows: Ratnapura (2), Lunugala (2), Udapussellawa (1), Maturata (1), Haputale (1), Galle (2), Dickoya (2), Dickoya Lower (1), Kotmale (2), Dimbula (6), Badulla (1), Maskeliya (3), Madulsima (1), Pusellawa (3), Lunugala (1) Kelani Valley (1), Nilambe (1), Yakdessa (1), Kegalle (1), Rakwana (1), Kelebokka (1) and Passara (1).

7.3. *Nitrogen.*—There were fewer instances of this deficiency reported during the year, compared to in 1962 when 20 estates were involved. In 1963, it was identified in specimens sent to the laboratory by 7 estates only, and on 5 further estates where visits were made to the field or nursery. There were 3 estates involved in Maskeliya district, 2 each in Kotmale and Dickoya Lower districts, and 1 each in Ratnapura, Badulla, Madulsima, New Galway, Udapussellawa and Dimbula districts.

7.4. *"Nutrient" spray mixtures*

The popularity of the mistblower as a means of covering rapidly with protective copper spray against Blister Blight an appreciably larger acreage of the tea per working day and at a cheaper rate per acre per day per labourer than is possible with the knapsack sprayer, and also considerations of economy in costs of production, has led many estates to apply Zinc Sulphate, Magnesium Sulphate and Urea in admixture with the particular copper formulation used, where the use of a mixture is indicated. There have however been cases where difficulty has been experienced in getting the Magnesium Sulphate to dissolve completely in the spray solution with consequent liability to cause blockage of spray nozzles, and the leaving of a residue either in the mixing or the sprayer tank. This residue may cake into a hard mass. The trouble can arise when Kieserite is used instead of Epsom salts. Both Kieserite and Epsom salts are Magnesium Sulphate, but Kieserite does not dissolve in water as readily as Epsom salts which is a purer crystaline product. If Magnesium Sulphate is ordered from the supplier, the supplier will have fulfilled the order correctly if Kieserite is sent. Epsom salts should therefore be stipulated by name.

7.5. *Boron.*—Cases of this deficiency which were detected in plant specimens during the year numbered 3 only, and all of them occurred in Grevillea shade trees. 3 estates were involved in Kotmale, Udapussellawa and Madulsima districts. 15 additional enquiries were received on the subject, and dealt mainly with questions of treatment, occurrence in particular areas, possible association with the survival of tea under drought conditions where the deficiency occurs (one extension experiment dealing with the question and was begun during the year in the Badulla district), and questions related to soil analysis.

7.6. *Potash deficiency.*—Only 3 cases of this were recorded in specimens ent. These occurred on three separate estates in Haputale, Dimbulla and Dickoya districts.

3. Carbohydrate (starch) deficiency

Tea bush specimens sent by estates for examination either had this defiiency present in the roots without there being any other associated fungal or ther complex, or had such complexes as well. Where no other condition xcept starch deficiency could be detected, V.P. mother bushes from which uttings had been removed too frequently, or cases where either too hard runing or the leaving of too few leaves on the bush at the time of pruning

(depending on the climatic conditions in the area) were usually involed. Where pests and diseases and the results of attacks by these were associated, starch deficiency was most commonly found together with Shot-hole Borer and termites and wood-rotting fungi, the effects of which had been cumulative over a period of time. Cases of these above conditions were recorded from 22 estates in 15 different districts during the course of the year.

9. Pests

9.1. *Tortrix.*—A total of 34 estates in 22 different districts either sent specimens to the Advisory laboratory or were visited by the Advisory staff from St Coombs during the course of the year, and a further 24 enquiries from 18 estates were received on the subject. Numbers of estates in each district from which specimens were received, or to which visits were made, were as follows: Ramboda (1), Dimbula (5), Kotmale (2), Pussellawa (6), Dickoya and Dickoya Lower (2), Maturata (2), Kalutara (1) Passara (1), Hewaheta Upper (1), Badulla (2), Haputale West (1), Rangala (1) Udapussellawa (1), Ratnapura (1), Galle (1) Dolosbage (1), Rakwana (1), Kelani Valley (2), Maturata (1), Nilambe (1) and Hantane (1). Reports of attack by Tortrix were recorded in all months of the year from these particular estates except in May.

9.2. *Shot-hole Borer*

34 estates in 24 different districts sent specimens in which Shot-hole Borer was found, or were alternately visited in this connection, and a further 33 general enquiries were received. As reported last year, Telodrin and Aldrin were investigated by the Entomology Division as being chemicals promising a likelihood of producing less of a Tortrix side-effect than Dieldrin, and of these Aldrin has now been found useful in new clearings, but to date has not been recommended for use amongst mature tea. Amongst the general enquiries that were received during 1963, interest was generally centred in the possible use of these alternative chemicals and also in the mistblowing of Dieldrin. One estate also mooted the idea of incorporating D.D.T. with Dieldrin, which did not have Institute sanction at the time (in June) but was nevertheless being investigated.

It would appear from results of experiments with Dieldrin by the Entomology Division that the improvement in yields per acre of tea after spraying in areas which have been badly attacked by Shot-hole Borer, more than offsets the temporary loss of crop resulting from Tortrix, provided Tortrix itself is controlled in good time. Estates which have feared to use Dieldrin on account of Tortrix (and Mites after Tortrix) may well encounter conditions, if chemical control of Shot-hole Borer is totally neglected, in which loss of crop resulting from this pest over a prolonged period of time, due to progressive reduction in efficiency of the bush to take up fertilizer, the gradual deterioration of the frame, and lowered efficiency of storage of starch reserves necessary for recovery from pruning, may over a succession of cycles do far more cumulative damage to the health of a tea bush than any which Tortrix or Mites, in a Shot-hole Borer protected bush, could inflict in the same time.

9.3. *Mites.*—Scarlet Mite was reported in respect of 14 estates, Red Spider mite 18 and Yellow mite 17 amongst specimens received at the Institute. 26 districts and 38 estates in all were involved in respect of all these three mite species. 12 additional general enquiries were received on the subject. Mite attacked specimens were recorded from the following districts: Pundaluoya, Matale East, Dickoya, Nilambe, Kalutara, Dimbula, Knuckles, Badulla, Madulsima, Udapussellawa, Matale South, Rakwana, Dolosbage, Pussellawa, Kegalle, Kelani Valley, Haputale, Kotmale, New Galway, Ratnapura, Hantane, Nilambe, Maskeliya and Rakwana.

9.4. *Other pests.*—reported included the following: Figures given in brackets are in respect of numbers of estates in each case.

Meadow Eelworm (24), White grub (11), Scale Insects (14), Termites (12), Leaf miner (4), Bag worm (7), Tea Aphis (6) Nettle grub (6), Thrips (3), Army worm (4), Lygus Bug (2), Capsid bug (1), Weevils (2), Bark-eating borer (1), Faggot worm (1), Lobster Caterpillar (3), Red Slug (2), Dasichyra horsefield (1), Tenas brecabe (1), Helopeltis sp (1), Cut-worm (3), Mealy bug (4), Cyclopelta siccifolia (1), Taragama dorsalis (4).

10. Physical and cultural conditions

10.1. *Failure or unsatisfactory growth of V.P. cuttings in nurseries*

27 estates in 15 districts reported trouble of this kind in their nurseries to the Advisory Division. This problem can be of sufficient magnitude on occasions to cause a restriction in the acreage that some estates may dare to open up or replant in new clearings in any one year until success in the nursery and the required number of plants suitable for putting out in the field can be guaranteed. Soils of too heavy or too clayey a texture for successful rooting of cuttings, often in conjunction with insufficient outlet for drainage from the sides and bases of polythene bags, particularly if the bases of the bags are in direct contact with nursery bed soil which itself is too clayey, is a most frequent source of trouble. Nearly every case of unsuccessful striking of cuttings which reached the Advisory laboratory had symptoms either of excessive formation of callus at the base of the stem of the cutting, or the stem itself was rotted. Mention of these problems and means of overcoming them was already made in last year's annual report for 1962. Attention could also be paid to the manner in which the cuttings are planted and set out in the nursery block. The over-lapping and contact of the mother leaf of one cutting with that of its neighbour and the insertion of the stem of the cutting into the soil at too inclined an angle, or too deep, so that the base of the leaf petiole contacts the soil along part of its length, or watering or heavy rain drops passing through the overhead shade canopy resulting in the splashing and deposit of soil on to the leaf, or its lodging in the angle between base of the mother leaf and the stem, can also be a frequent cause of damage to the mother leaf on its surface, or rotting and detachment of the petiole from the stem, as well as rotting of the young shoot or shoot bud itself. Weather conditions at certain times of the year as opposed to other times in relation to nursery conditions and comparative numbers of successes with cuttings planted at different times, may well repay further study.

10.2. *Collar rot and collar scorch of young plants in clearings*

The causes of these types of damage are various, namely the contact of the soil with the collar above the correct planting level either through displacement down slope, heaping up in the course of cultivation such as weeding, too deep planting; too close proximity of thatching material, or contact with a highly concentrated deposit of chemical such as fertilizer too liberally applied. In certain cases also, where the collar has been partly buried by soil displacement and there has been wet weather with a high wind, rotting may take place in the collar region below the soil level through damage caused by the constant movement of the plant in the wind. Wnen it has been loosened, a callus may form at soil level which may sometimes be mistaken for collar canker caused by Leptothyrium, but in fact is not due to this fungus.

Cases of collar rot and collar scorch, sometimes with the accompanying callusing were diagnosed during 1963 in specimens from 34 estates in 19 different districts.

10.3. Other relatively common types of cases reported were Die-back and Wood-rot (24 estates) and Chemical scorch and phytotoxic damage symptoms in the leaf (15 estates).

11. General Enquiries (excluding specimen examinations).

11.1. *Fertilizer application, Fertilizer chemicals and mixtures, and fertilizer policy.*

146 estates made enquiries under these headings during the year, 51 of which were concerned with matters of general fertilizer policy affecting levels of application of N.P.K. mixtures (in terms of lbs Nitrogen per acre per annum) to mature tea. The new recommendations which were published in this connection in the Tea Quarterly dated September 1963 were not generally available in print until December. Round about July, however, estates began to be notified of the impending change-over (from the earlier method of graphing to that of the new system,) and these estates elected to wait until new recommendations were finalized. 115 of these 146 estates made enquiries in connection with fertilizer chemicals and various types of fertilizer mixtures in general including applications of zinc, magnesium, boron and of nitrogen as urea or in granular compounds.

11.2. *Vegetative propagation techniques and clones*

(i) 63 estates made enquiries in regard to various aspects of V.P. technique in nurseries or in regard to technique of selection and vegetative propagation in all its known aspects. There were also a large number of estates which sent in soil samples for analysis of pH and report on soil texture in regard to suitability for use in V.P. nurseries, as well as numerous requests for literature on the subject in general, including some from abroad.

(ii) *V.P. tea and drought in Uva*

A start was made during the year on this problem with trials of survival of V.P. and seedling tea positioned in selected areas on particular estates, and details of a standardized lay-out were made available to estates whose co-operation could be enlisted or who were interested. Exploration of closer details concerned with the problem in general, by survey and extension trial methods, following the initial preliminary survey carried out and discussed at the Uva P.A. meeting in the latter quarter of 1962, had to be postponed during 1963 until such time as the necessary cadre of advisory staff could be made available and operative principally from the T.R.I. Sub-station in Passara itself in order to be able to devote more time and to travel lesser distances than is possible from St Coombs. However, with the establishment of a district advisory service last August, and the expectation of more staff, it is at least hoped that the problem will in 1964 be able to be tackled in greater detail.

11.3. *Weed-control*

Enquiries on this subject were received from 33 estates during the year and a further 10 enquiries came from non-estate courses. The Institute has remained in a relatively lagging position in regard to trials with weed-killers for reasons stated in the previous report for 1962, but the position is now being remedied. Interest by enquirers during the year was mainly shown in regard to Simazine and Dowpon, but queries were also received on Karmex Diuron, Gramevin, Gramoxone, Fernoxone and Sodium Arsenite. Of recent interest has been the question of the long-term effects of repeated application on the soil and the result that this might have in time on the satisfactory growth of tea. Assurance has been given that in the case of those compounds which break down under the influence of soil micro-organisms and change thereby

chemically into harmless products, no deleterious effects may be expected provided that the interval between sprayings is not persistently shorter than the period required for the breakdown point to be reached.

11.4. *Advisory literature and other publications*

Close on 200 requests for leaflets, reprints of Tea Quarterly articles, R. L. Illankoon's booklet on Tea Cultivation and for monographs were received and answered during the year. As was the case in previous years, the bulk of these requests came from students at Universities, Technical Training Colleges, Practical Farm Schools and other educational establishments, while the remainder came from estates, private individuals, Agricultural Inspectors and Instructors and also from Government departments. Requests, also came from Pakistan and New Zealand.

11.5. *Other general enquiries* (excluding specimen examinations and estate visits.

The following additional number of enquiries on subjects not yet mentioned were also received and answered:

New planting, replanting, rehabilitation and associated crops (3), Pruning (23), Bringing into bearing (3), Ground covers and cover crops (9), Shade, Fuel Trees and wind-belts (19), Tea seed and tea seed supply (31), Seed supply other than tea seed (6) Mistblowers, general information (5), Exhibitions and shows (11), Training courses (6) Cultivations (10), Soil reaction (Not pH samples) (5), Compost and compost making (3), Blister Blight and Copper formulations (11), Mossing and ferning (7), Plucking and tipping (4) Suitability of land for opening up in tea (9), Lightning damage (1), Copper contamination in made tea (1) and Leech control (5).

12. Exhibitions

12.1. The Advisory Division in co-operation with other divisions of the Institute contributed exhibits at the Nuwara Eliya Agricultural-Horticultural Show which took place from 18th to 20th April.

12.2. There was also a Rural Exhibition at Wattadara from 15th to 17th November, at which a stall was contributed.

13. Symposia

Two papers entitled "Soil erosion and tea bush cover under Ceylon conditions", and "The application of NPK fertilizer mixtures to mature tea in Ceylon—A historical review", were written and read by the Chief Advisory Officer at the Annual Symposium of the Soil Conservation Society of Ceylon and at the Ceylon Association for the Advancement of Science sessions in Colombo on the 14th and 21st of November respectivly.

ANNUAL REPORT OF THE DISTRICT ADVISORY OFFICER—UVA

L. de W. Tillekeratne, B.Sc., M.Ed.

Staff

The District Advisory Officer—Uva, was appointed on 1st August 1963, and took up his residence at the T.R.I. Sub-station, Passara, located on Gonakelle Estate from that date. Temporary clerical assistance was available.

Buildings

An extension to the present laboratory was started in December, and when completed should give sufficient work space for the Advisory Officer;

Correspondence and Visits

88 letters were received
154 ,, ,, despatched.

Advisory visits were made to 40 estates during the period August—December 1963. In addition 3 visits in connection with the inspection of land for the Ceylon State Plantation Corporation. 7 visits were made to estates regarding estate trials, making a total of 50 visits for this period. 3 P.A. meetings were attended. 10 Superintendents and Assistant Superintendents visited the Sub-station on advisory matters.

Diseases, Pests and Deficiencies

The following numbers of cases were dealt with in the course of examination of specimens in the laboratory, during estate visits, and through general enquiry from estates concerned:—

Poria hypolateritia (2), *Ustulina deusta* (*zonata*) (1), Drought (1), Collar rot (2), starch deficiency (1) Wind damage (1), Manure toxicity (1), chlorosis not due to pest or disease (2), Nettle-grub (1), Shot-hole Borer (4), Mites (2), Cut-worm (2), Meadow eelworm (3), Zinc (11), Magnesium (8), Potash (6) and Boron (2).

Physical and Cultural Conditions

(*a*) *V.P. Nurseries.*—Failures appeared to be due mostly to heavy textured soils and poor drainage. Another factor of poor success was regular supplying of cuttings that have died in the same polythene sleeves, with the result that there is a range of cuttings of age 1-2 weeks up to about 4–5 months old growing under the same conditions and hence the newly planted cuttings tend to suffer.

(*b*) *Pruning.*—The general problem appears to be of fields taking a longer time to recover after pruning, a few casualties and more die-back. This may be due to some estates pruning harder to accommodate longer pruning cycles. With most estates getting average yields of over 1,000 lb per acre, the time of the year for pruning, especially in Uva, may become crucial, due to the question of starch reserves. Most estates do a part of their pruning during June, just after or during their rush, when the reserves are low, which might account for the slow recovery. It also may be important to vary the type of pruning (with or without lungs, resting *etc.*) depending on the time of year in which pruning is undertaken. This question needs immediate investigation.

(*c*) *Shade.*—The question of shade, especially in new clearings assumed importance in regard to competition for water during drought versus reduction in transpiration. More field trials are necessary on this problem.

Fertilizer application, Fertilizer Chemicals and Fertilizer Policy

Most of the advice was on the foliar application of zinc and magnesium. Advice was given to a few estates on their general manuring programme especially where their estimates for 1964 were concerned.

Field Trials on the Sub-station

(1) *Pruning Experiment 1.*—A preliminary pruning experiment was started in October 1963, on a block of Clone No. 2027, to test 3 types of pruning (1) Control-low cut across (2) Rim-lung pruning, (3) Pre-pruning. Records will be kept of tippings, die-back and any casualties.

(2) *Pruning Experiment 2.*—This experiment is conducted on an old spacing experiment. Treatments are (*a*) 3 clones (2024, 2025 and 2026) (*b*) 3 methods of pruning (same as above) (*c*) Different periods of resting before pruning. A split plot design is used with a total of 81 plots, giving 9 replications of the main treatment, and 27 replications for sub-treatments. This experiment was started in October and root samples for starch estimation were taken. Pruning will take place in March 1964, when root samples for starch estimation will again be taken to find the effect on starch reserves by resting.

These experiments are conducted in conjuction with the Plant Physiologist.

Estate Field Trials

Queenstown—Hali-Ela.—An experiment to determine (*a*) the proper time for the 1st pruning of V.P. tea in Uva (*b*) the possible causes for the peripheral scorch which appears on the first shoots after pruning was started in October 1963, on a patch of Clonal tea (Clone 2024) in the 1961 new clearing on Queenstown estate.

The treatments were:—

(1) Pruning at the end of the drought (October 1963).

(2) Last application of manure in December/January (1963/64).

(3) Replacing of muriate of potash, with sulphate of potash in the manure mixture.

(4) Control—same treatment as already given in 1960 clearings—Pruning in March 1964.

A fifth treatment of resting versus no resting was introduced into the plots due to be pruned in March 1964. The plots are laid in a random block design, with 2 replications of each treatment.

Root samples for starch estimation were taken at the October prune, and will be taken again at the March pruning.

This experiment is conducted in conjunction with the Agricultural Chemist.

Batawatte Group—Madulsima

An experiment to determine the effect of shade on new clearings was started in October 1963, on the 1963 new clearing on Batawatte Group.

The treatments are:—

Main treatments.—2 species of shade trees—Albizzia and Acacia.

Sub-treatments.—(1) Planting shade with the tea (2) Planting shade one year after the tea (3) Planting shade 2 years after the tea.

Experiments consist of 12 plots, each sub-treatment being replicated 4 times.

Ury Group—Passara

(1) A pure observational experiment to observe the effect of the best treatment to be given to bushes after a bad attack of nettle grub was conducted on No. 2 Field on Ury Division. 3 treatments namely (*a*) Resting (*b*) Skiffing, (*c*) continuous plucking was tried on one acre per treatment. From observation to date, resting seems to be the best method to help the bushes to recover after a bad nettle grub attack.

(2) Arrangements were made to conduct a time of pruning experiment at two elevations, on Ury Division, and Agratenne Division located on Ury Group. The objectives of the experiment is to prune 90 bushes on the 15th of every month, except June and November, and to keep records of the number of days to tipping, die back, *etc.* In addition root samples for starch estimation will be taken at the time of pruning to observe the fluctuation in starch reserves throughout the year. The plots are laid in a random block design, with 3 replicates per treatment, giving a total of 30 plots at each location. This experiment is conducted in conjunction with the Plant Physiologist.

Demodera Group

Arrangements and marking out of the plots for an experiment to determine the effects of foliar application of zinc sulphate on Demodera Group new clearings were completed at the end of the year. 3 clones, Miriekelle 14 and 6, and T.R.I. Clone No. 2025 are used in this experiment. The treatments are:—

(1) Control—no zinc applied
(2) 2 sprays per year at rate 1
(3) 4 sprays per year at rate 2
(4) 2 sprays per year at rate 2
(5) 4 sprays per year at rate 2.

Rate 1—10 lb zinc sulphate per acre per year.
Rate 2—20 lb ,, ,, ,, ,,

This lay-out is a split plot design, each treatment replicated twice in each clone, making a total of 30 plots. Pre-treatment plucking will commence in early 1964.

This experiment is conducted in conjunction with the Agricultural Chemist.

Welimada Group

An experiment to determine the best method of bringing into bearing V.P. tea in the second year, was initiated on Welimada Group, on the 1962 clearing with clone T.R.I. 2025.

The treatments are

(1) Cutting the bushes in December/January (1963/64), and light plucking until May/June 1964.
(2) Cutting the bushes in December/January (1963/64) and no plucking.
(3) Cutting the bushes back in May/June 1964.
(4) Continuous light plucking the bushes with the N.E. rains in 1963 and no cutting back.

The plots are laid out in random block design, each treatment replicated 6 times, giving a total of 24 plots. Plot size, one row consisting of 20 bushes.

Acknowledgments

Our sincere thanks are due to the Managers of Ury, Demodera; Battawatte; Welimade and Queenstown, for their kind co-operation in helping us to carry out these experiments, and to the Heads of Research Divisions for their help and guidance.

REPORT OF THE ADVISER IN PLANT PATHOLOGY FOR 1963

A. Kerr, Ph.D.

Staff

Dr Shanmuganathan was Acting Plant Pathologist until September when he was promoted to the senior staff post of Plant Pathologist. I took up my appointment on 11th September. Dr R. L. de Silva returned to the Institute in October after successfully completing three years post-graduate work at Imperial College, London.

General

Ninety eight estate visits were made during the year; 232 letters were received and 220 sent.

1. Blister Blight (Exobasidium vexans)

1.1. *Fungicide Trial*

In the 1963 fungicide trial on Field No. 6 at St. Coombs, three new products, YF 6011 (a formulation of oxides of copper and zinc), a new formulation of triphenyl tin acetate (TPTA), and Difolotan, an experimental organic fungicide in which the active ingredient is N– (1,1,2,2,— tetracycloethylthio)–4–cyclohexane–1,2–dicarboximide, were compared with a standard 50% copper fungicide (Perenox). The dosage rates tested were ½, 1, 2 and 4 oz. per acre, a randomized block design being used.

The trial was started in May and continued till the end of the year; 24 spray applications and 25 assessments for blister blight infection were made during this period. The south-west monsoon was rather late to set in, but was moderately severe towards the end. The usual break between monsoons was not evident this year and the trial was continued into the north-east monsoon. The mean infection in the control plots over the entire trial was 32.4%, indicating that weather conditions were more favourable for blister blight than in 1962 (mean infection, 26.9%). Results are given in Table 1.

TABLE 1.—*Incidence of Blister Blight in Fungicide Trials*

% *Infection* (*Transformed Data*)

Fungicide	Perenox	YF 6011	Difolotan	T.P.T.A.	Control	Significant Difference (P = 0.05)
Treatment Means	21.64	22.04	26.50	29.670	34.21	1.25
Rate of application (ozs/acre)	4	2	1	½		
Means of Levels	23.21	24.12	25.38	27.14		1.25

Of the 3 new products tested, only YF 6011 gave protection as good as Perenox. Difolotan and TPTA were both significantly inferior to Perenox, although Difolotan was superior to TPTA. These results confirm previous findings that organic fungicides are not as good as standard copper preparations for blister blight control, and also that tin preparations are ineffective (Shanmuganathan, 1963).

Significant differences between application rates were also observed One, 2 and 4 oz. doses gave better control than ½ oz.; 2 and 4 oz were significantly better than 1 oz. In a similar trial last year, there was no significant difference between 1, 2 and 4 oz. Although in that trial some of the products used were different, there is some indication that as field infection increases, lower rates of application (½ and 1 oz.) become ineffective.

The results also indicated a linear relationship between log-dosage and percentage kill (expressed as a percentage of the control). Straight lines were obtained when log-dosage was plotted against percentage kill (probits), but the slope was significant for Perenox only ($b=0.8$, $P<0.05$). It is clear from this that for Perenox, there is better control with increasing dosage for all dosages tested.

The good performance of YF 6011 is important in view of its composition. This product will be tested again in 1964, and if satisfactory it may find use on estates where there is zinc deficiency, pending results of experiments to be done by the Agricultural Chemistry Division on the value of Zinc Oxide for this purpose.

1.2. *Taint Tests on Tubosan*

In collaboration with the Technology Division, taint tests were carried out on Tubosan, a product previously shown to be effective against blister blight (Mulder, 1961 and 1962). The results were inconclusive and further tests are planned for 1964.

1.3. *Epidemiological Studies*

The Hirst spore trap was in operation throughout the year on Field No. 9, but there were three serious interruptions due to defects in the suction unit of the trap. No catches were made in April, June, part of July and December. High catches were recorded in May (14,200 spores per cu. m. air) and in September (11,600); the lowest was in August (4,700). Unfortunately no records are available for June, when numbers were expected to reach a peak. As in 1962, large numbers of spores were trapped during the drier months of February and March (7,850 and 6,000 respectively), when field infection was negligible.

Two-hourly counts of catches, made during certain periods selected at random, indicated a strong positive correlation between spore concentration and relative humidity ($r = +0.812$) and an equally strong negative correlation between spore concentration and temperature ($r = -0.805$). A negative correlation with wind-speed was also observed ($r = -0.651$). Thus high night catches seem to be associated with high relative humidity, low temperature and low wind speed—conditions favouring dew formation.

Pruning of tea in a neighbouring field resulted in a marked increase in the overall daily catches as long as this operation was in progress. Numbers returned to the normal level immediately after pruning was over, indicating a marked biotic influence on atmospheric spore concentration. Field operations like spraying and plucking, however, did not materially alter the spore concentration.

1.4. *The Infection Process*

A project to study in detail the infection of tea by the blister blight fungus has started. At present the work has been confined to the development of suitable techniques.

2. Red Root Disease (Poria hypolateritia)

2.1. *Fumigation Trials on Estates*

Two large scale fumigation trials with D.D. were completed in 1962 and the remaining six during 1963. Plants of *Tephrosia vogelii* grown on the treated plots were uprooted and the number of points of residual infection in each plot recorded. As in previous trials, 2,000 lb D.D. per acre was the most effective treatment. Only 5 out of 48 plots treated with this level of D.D. showed any residual infection, and these were invariably on the perimeter of the treated patches and associated with poor clearing before fumigation and with re-infection from adjoining infected tea. Again, 1,000 lb and 1,500 lb D.D. per acre proved ineffective; 28 out of 50 plots treated with 1,000 lb., and 14 out of 30 treated with 1,500 lb carried residual infection. On two of the estates, 3,000 lb D.D. was tested at two depths, 12 and 24 inches, but control was surprisingly poor. It was again evident that best results are obtained when injection is made at 6 inches rather than at 12 or 24 inches. This has been confirmed by more detailed field experiments (see section 2.22).

Tea has been planted on 4 of these estates. On one estate it is now nearly 2 years old and on two other estates about a year old. No casualties have been observed on plots treated with 2,000 lb D.D. Plots which showed residual infections were re-fumigated with 2,000 lb D.D. and also planted with tea. No deaths have occurred in these plots either. The tea will be examined periodically up to two years from planting. The remaining estates will be planted with tea in 1964.

Nine more trials were started in 1963 on private estates. On each estate an area of approximately $\frac{1}{4}$ acre, comprising 1—3 *Poria* patches, has been fumigated with 2,000 lb D.D. at 6 inch depth and then planted with *T.vogelii* Residual infection has not yet been assessed.

Several estates have started trials on their own, and officers of this Division have visited many of these estates to demonstrate fumigation in the field.

2.2. Field Experiments

2.21 *Longevity tests:*—These tests were to determine the survival of *P. hypolateritia* in infected tea roots of different diameter in fallow soil. Root segments, 6 in. long and 1, 2 or 3 cm. in diameter were artificially inoculated with *P. hypolateritia* and buried in fallow tea soil at a depth of 1 ft. Every three months, 10 segments of each thickness are removed and the viability of the fungus determined. Results at the end of one year are given in Table 2.

TABLE 2.—*Survival of P. hypolateritia in infected Roots of different Diameter (No. of root segments with viable fungus, out of 10).*

Thickness of Root Segment (cm.)	Time of sampling (months)			
	3	6	9	12
1	10	7	7	5
2	9	10	10	9
3	9	10	10	9

At the end of 12 months, all root segments were in an advanced stage of decay. The experiment will be continued for one more year.

2.22 *Depth of penetration of D.D.*—The effective depth of D.D. fumigation was studied in a pit trial in which infected root segments were buried at several depths ranging from 6 in. to 3 ft., and D.D. injected at 6 in. and 12 in. Results showed that injection at 6 in. gave better overall control than injection at 12 in. Injection at 6 in. gave 100% control up to 12 in., 50% control at 18 in. and little or no control at 24 in. or below. With injection at 12 in., control in the top 1 ft. was poor compared with injection at 6 in., and there was only a slight improvement in the control below 1 ft.

In an attempt to improve the penetration of D.D., the effect of deep forking prior to fumigation was studied. Ten plots were forked using a 16 in. fork, and 10 were left unforked; 5 plots in each series were fumigated with 2,000 lb. D.D. injected at 6 in. and 5 at 12 in. Results showed that overall control was significantly less in the forked plots, compared with the unforked plots. Injection at 6 in. was again superior to injection at 12 in. It appears that forking allows the fumigant to escape more rapidly resulting in poor control near the surface. A surface seal, more efficient than thatching with Guatemala grass, may be necessary.

2.23 *Efficiency of different methods of sealing the soil surface after fumigation with D.D.*—In a field experiment on Mattakelle Estate, adjoining St. Coombs different methods of sealing the soil surface after fumigation are being compared. Infected roots were buried in plots 10 × 15 ft., fumigated with D.D. at the rate of 2,000 lb. per acre, and then the soil surface treated as follows:—(1) Covered with a thick layer of Guatemala grass loppings, (2) Watered lightly and then covered with Guatemala grass loppings, (3) Covered with polythene sheeting, (4) Watered and covered with polythene sheeting, and (5) Watered lightly. Results are not yet available.

2.24 *Soil fumigation with Vapam.*—A trial on St. Coombs to test the efficiency of Vapam as a soil fumigant to control *Poria* was concluded during the year. Six treatments were involved in this trial, *viz.* 100, 150 and 200 gl. per acre injected at 1 and 2 feet in each case. Residual infection was assessed by planting *T. vogelii* as an indicator crop. Results indicated that only 200 gal. per acre injected at 1 ft. was satisfactory. More trials with this product are planned for 1964.

2.3 *Pot Experiments*

2.31 *Soil fumigation.*—In a pot trial in the glasshouse, two soil fumigants, Vapam (sodium dimethyl dithiocarbamate) and Trapex (methylisothiocyanate) were compared with D.D. for control of *Poria.* Infected root segments were placed in pots, covered with soil and then fumigated with different quantities of the chemicals. The effectiveness of treatment was assessed by sowing *T. vogelii* in the pots and determining the percentage infection after 6 months. Results indicated that Vapam was promising, although not as good as D.D., and that Trapex was ineffective.

2.32 *Resistance of clones.*—Twenty three clones are being tested for resistance to *Poria* in a pot trial at St Coombs. The clones are D, DT 1, H6A 1, H13/4, MG, MG3B1, MPA/1, MT/BG, N2, N3, NK4/B29, PO26 and TRI clones 25, 777, 2016, 2020, 2022, 2023, 2024, 2025, 2026, 2039 and 2043. Rooted cuttings (1-2 years old) were potted in November, 1962 and inoculated with *Poria* in July, 1963 and again in November, 1963. By the end of December clones MG3B1, MPA1, NK4/B29, PO26 and TRI 777 were showing obvious signs of infection, but it is too early to claim that the other clones have worthwhile resistance.

Cuttings have been taken from healthy plants in *Poria* patches in mature tea fields and will eventually be tested for resistance.

2.4 *Laboratory Studies*

In preliminary studies to select a suitable basal medium for detailed investigations of the nitrogen metabolism of *P. hypolateritia*, 5 synthetic liquid media with added yeast extract were used. After 21 days incubation at 28°C, the weight of mycelium was measured; the media supported growth in the following order: Czapek's > Richard's > Knop's > Asthana and Hawker's > Pfeffer's.

Experiments using Czapek's solution plus thiamine as a basic culture medium indicate that *P. hypolateritia* is able to use asparagine freely as a source of nitrogen. Ammonium tartarate supported moderately good growth, while there was very poor growth with ammonium nitrate and sodium nitrate. There was no growth where urea was used as the sole source of nitrogen.

3. Collar and Branch Canker (Leptothyrium theae; Macrophoma theicola, and Phomopsis theae)

The fungus isolated from several diseased bushes collected from different localities has now been identified as *Phomopsis theae*. It has not been possible to isolate either *Leptothyrium theae* or *Macrophoma theicola* from any of the specimens examined.

Inoculations with *P. theae* on young V.P. plants in the glasshouse resulted in cankers that were not quite typical of those found in the field. Inoculation of plants in the field at Nayabedde confirmed the pathogenicity of *P. theae*, but again the cankers obtained were not typical and resembled those normally attributed to *M. theicola*. The typical collar canker resulting in ring-barking, of the bush at ground level was never observed.

During a visit to S. India, Dr Shanmuganathan observed a field where *L. theae* had caused considerable damage to tea recovering from pruning. The fungus had killed several of the new shoots that grew out after pruning. This kind of damage is quite unlike that seen in Ceylon, where most of the trouble is at the collar. As *L. theae* has not been isolated from any of the affected bushes, it would appear that this fungus is not the cause of the disease in Ceylon. Pure cultures of all three fungi have now been obtained and comparative pathogenicity studies will be commenced shortly.

The spraying trial at Nayabedde where 4 different fungicides are being tested for control of collar and branch canker (Shanmuganathan, 1963), has not yielded any result so far. The tea is now over two years old, but there is still no sign of either branch canker or collar canker, even in the untreated plots. The trial is continuing.

During the year two experiments, one at Nayabedde and the other at Downside, Welimada, have been laid out to study the effect of bending against non-bending on the incidence of the disease. In these experiments young tea of clones TRI 2024 and N3, both known to be very susceptible, will be brought into bearing either by bending or by thumb-nailing. The tea is now more than a year old and the first treatments have already been given. Incidence of cankers will be determined over a few years after the tea is brought into plucking.

4. Oil Spot Disease

No further progress was made in 1963 in the study of the disease. The fungus consistently associated with the disease has still not been identified, nor have inoculations with the fungus induced the symptoms of oilspot.

5. Black Blight (Rhizoctonia solani) in the Low-country

No fresh outbreaks were recorded during the year, and experiments to test the efficiency of several different fungicides in the control of the disease could not be carried out.

6. Maintenance Leaf Fall

The experiment at Millakande, Bulatsinhala, on the control of maintenance leaf fall was concluded during the year; it had been in progress for one full pruning cycle extending over 24 months. The treatments in the experiment were:

A. Monthly spraying with Zineb throughout the cycle.

B. Monthly spraying with Zineb beginning 10 months after pruning.

C. Monthly spraying with Perenox throughout the cycle.

D. Monthly spraying with Perenox beginning 10 months after pruning.

E. Cleaning frames after pruning; no spray applied.

F. Untreated.

One year after the commencement of the experiment, monthly assessments were made of the amount of leaf fall and the extent of fungal colonisation; yield records were maintained throughout the cycle. At the conclusion of the experiment, the prunings from 10 bushes in each plot were collected and weighed The results will be published in more detail in the Tea Quarterly, but the following general conclusions can be drawn: (1) All treatments reduced leaf fall and the amount of fungal mycelium on the bushes and (2) there was no significant difference in yield between treated and untreated plots. It would appear either that maintenance leaf fall does not adversely affect yield, or that the amount of control obtained was insufficient to affect the yield. As there was no significant difference between the various treatments, it would appear that cleaning frames after pruning is as effective as applying fungicides periodically.

7. Diseases of Cover Crops and Shade Trees

7.1 Guatemala Grass (Tripsacum laxum)

7.11 *Bacterial leaf stripe* (*Xanthomonas sp.*)—Attempts to isolate bacteriophages active against this bacterium in order to identify it fully and to study its affinity with the bacterial pathogen on sugar cane (*X. vasculorum* Dowson) were unsuccessful.

The susceptibility of Mana grass (*Cymbopogon confertiflorus*) and 3 other potential rehabilitation crops, Napier or Elephant grass (*Pennisetum purpureum*), Khas-khas (*Vetiveria zizanoides*) and Guinea grass (*Panicum maximum*) was determined during the year. Repeated inoculations with different isolates of the bacterium showed that Mana, Napier and Guinea grasses are immune to this organism. Khas-khas, however, appears to be susceptible, symptoms of leaf stripe appearing 2-3 weeks after inoculation. Guatemala grass was used as a check in all inoculations; on this host typical lesions appeared after 2 weeks.

The pathogenicity of this organism to sugar cane is now being studied, in view of the increasing economic importance of this crop in Ceylon.

7.12. *Spikiness Disease.*—Further observations have confirmed that the spread of the disease is slow, and that the probable method of spread is by cuttings. Two more loppings taken from the experimental block, where healthy and diseased cuttings were interplanted (Shanmuganathan, 1963) confirm that the yield from healthy plants is significantly higher than from diseased ones, A well illustrated account of this disease was published by Mulder (1963).

TABLE 3.—*Yield of Guatemala Grass infected with Spikiness Disease*

Date of lopping	Yield (lb fresh weight/ 15 plants	
	Infected	Healthy
29–11–62	1361.0	1,473.0
15– 3–63	143.5	188.0
11– 7–63	356.0	440.0
Total	1,860.5	2,101
Increase Healthy over Infected	13%	

7.2. Gliricidia maculata

Stem cankers, 15 to 20 cm in length and probably originating from natural cracks at the crotches and from frame cuts on lopped trees, were recorded on Gliricidia trees growing at the Sub-Station at Kottawa. Two fungi were isolated, one from bark and the other from wood, but inoculations with these organisms on cut shoots in the laboratory failed to produce cankers. Following inoculations in the field at Kottawa, one of the isolates produced typical cankers, but not as large as those resulting from natural infection. This fungus has not yet been identified. It is suggested that cutting out cankers and painting exposed wood with a fungicidal paint, should control the disease.

Gliricidia trees showing intense chlorosis and defoliation are common in the low country, particularly after heavy rains and in badly drained soil. In one case roots had a waterlogged appearance; the bark was soft and moist and under it were thick strands of mycelium, orange in colour. On incubation, fructifications similar to those produced by *Xylaria* sp. appeared after a few days. The fungus has now been isolated and a few Gliricidia plants inoculated to determine whether it is pathogenic under normal conditions.

7.3. Dadap (Erythrina lithosperma)

A species of *Oidium* was observed on the leaves of young dadap plants in the glasshouse during dry weather, and was associated with premature yellowing and defoliation. The disease was controlled by spraying with Spersul, a wettable sulphur. This is apparently the first record in Ceylon of an *Oidium* sp. infecting *E. lithosperma.*

8. Miscellaneous

8.1. Decay of Shade Tree Stumps

During the year, 10 wood-rotting fungi were isolated from decaying stumps of *Grevillea, Eucalyptus* and unidentified jungle stumps. Five of these fungi are being tested on *Grevillea* wood to determine which fungus causes the most rapid wood rot. This work is being carried out in collaboration with the Forest Research Laboratory in Colombo.

8.2. Experiments with Arboricides to kill Shade Trees

A technique has now been developed for sampling roots for starch determination. Early results indicate no relationship between diameter of root and its starch content. The techniques will be used to determine the starch content of roots from trees treated with arboricides.

8.3. Ambrosia Fungus of the Shot-hole Borer

Several isolates of the ambrosia fungus have been obtained from galleries of the shot-hole borer, and also from larvae and adult beetles. The isolates are very variable with respect to growth rate, temperature response and pigmentation. The significance of the fungus in influencing the development of the insect will be investigated.

8.4. Visits and Lectures

In September, Dr Shanmuganathan attended the 10th Annual Conference of the United Planters' Association of South India (U.P.A.S.I.) held at Coonoor. He also visited some estates in the Nilgiris. A full report of his visit appears in the December issue of the Tea Quarterly.

Dr Shanmuganathan and Mr Arulpragasam read a paper at the 19th Annual Sessions of the Ceylon Association for the Advancement of Science on "The diurnal and seasonal periodicity of spores of *Exobasidium vexans* in the air of a tea estate".

A lecture on "Plant Pathology" was given by Dr R. L. de Silva to Botany students at The University of Ceylon, Colombo.

Publications

MULDER, D. (1963), Spikiness disease of Guatemala grass (*Tripsacum laxum* Nash). *Tea Quart.* 34, 16—18.

MULDER, D. (1963), Virus and virus-like symptoms on seedling tea. *Tea Quart.* 34, 19—21.

MULDER, D., SHANMUGANATHAN, N., and ARULPRAGASAM, P. V. (1963), Oil spot disease in tea. *Nature*, 199, 92.

SHANMUGANATHAN, N. and MULDER, D. (1963), Further observations on the oil spot disease of tea. *Tea Quart.* 34, (in press).

PETHIYAGODA, U. and SHANMUGANATHAN, N. (1963), Notes on a visit to the Tenth Annual Scientific Conference of the United Planters' Association of South India (U.P.A.S.I.) and to some tea estates. *Tea Quart.* 34, (in press).

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MULDER, D. (1962). Report of the Plant Pathologist for 1961. *Ann. Rep. Tea Res. Inst. Ceylon*, 95—99.

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REPORT OF THE ENTOMOLOGIST FOR 1963

J. E. Cranham, B.A., D.I.C., M. I. Biol.

1. General

Mr A. Rajendra, M.Sc. (Madras) joined the staff at Hantane in February and left to take up another appointment in November. Mr H. Samarakoon was appointed in August to join the staff of the Low Country Division but was seconded to Entomology Division for training until mid-1964. There were no other changes in personnel.

Mr. C. Shanmugam was made permanent on the staff as Technical Assistant.

The Entomologist was on furlough in Britain from July to September and during this time Mr D. J. W. Ranaweera acted on his behalf.

Estate visits by staff numbered over 300 and were almost entirely in connection with shot-hole-borer trials. There were 350 letters received and over 500 sent out.

2. Shot-Hole Borer

2.1. *Large-scale dieldrin trials on estates*

In this series of trials, described in the last annual report (Cranham, 1964), nine trials were pruned and completed in 1963 after 2½ to 3 year pruning cycles. Seven trials on tea running four-year cycles, at Uva Ketawella Estate and Balangoda, Queenstown, Demodera, Delta and Meddecombra Groups, were continued into 1964.

Thirteen trials have run for 36 months after pruning and spraying, and the results of the third year provide broadly- based information on the 'third-year build-up' of infestation on the sprayed plots (Cranham, 1963, 1963a). The graphs in Figure 1 are based on the average counts of infestation and galleries per 100 sample units, for each bi-monthly sampling period, for the dieldrin-sprayed plots and the unsprayed plots.

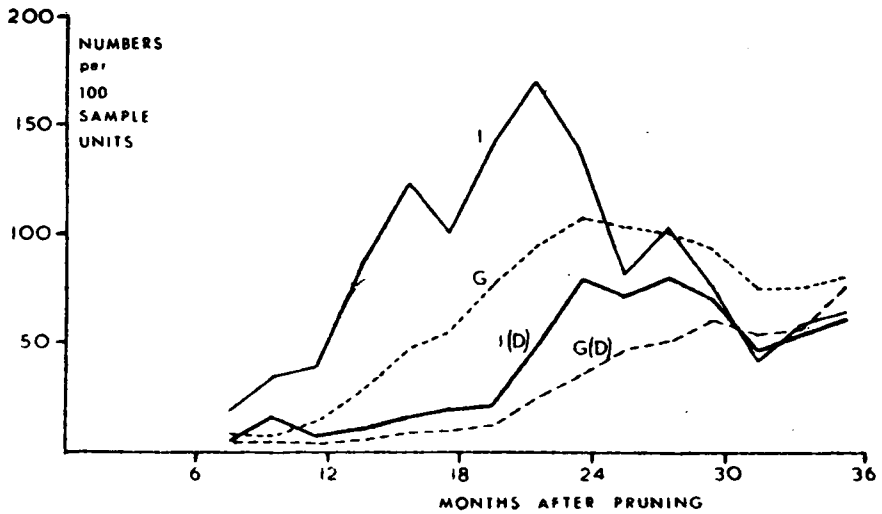

Figure 1—The results to the 36th month after pruning of 13 estate trials on the control of Shot-hole Borer; the number of live borers (I) and of galleries (G) per 100 sample units on the unsprayed plots; and the number of live borers (I(D)) and of galleries (G(D)) on the dieldrin-sprayed plots; based on the averages for each bi-monthly sampling period.

There was a third-year increase of infestation on the sprayed plots, but on average this was about half that which occurred on the unsprayed plots 10-12 months earlier, in the second year. In general, therefore, post-pruning spraying of dieldrin did more than delay the attack for about one year; the attack when it came was considerably reduced, and this is believed to be due to the

conditions for borer development being less suitable in the third year as the wood ages. These results were obtained on plots mostly of 5–10 acres in size and subject to heavy reinfestation from adjacent unsprayed plots. The results on whole fields, or groups of fields on estates, might be expected to show better duration of borer control in the third year after pruning, and in general appear to do so.

On the unsprayed plots, the pattern of heavy attacks on the different sites was remarkably similar, in that there was a rapid decline in numbers after the peak af attack; in general, the higher the peak of attack, the sharper the decline that followed. The peak number of galleries in heavy attacks was mostly between 120-150 and rarely exceeded 150 per 100 units. This evidence supports the idea that there is a ceiling on the number of galleries which the wood will carry—a *saturation density* of about 150 galleries per 100 sample units—and that the accumulated attack itself renders the wood increasingly less suitable for borer development, bringing about a decline in borer numbers. Whenever the density of galleries approached this level there was a marked and rapid decline in borer numbers. In these cases, the number of galleries per sample declined also in the third year, somewhat later and more slowly, but to an extent which was unexpected since galleries do not heal up internally in the wood but remain as a record of attack. This is believed to be due to recovery of the bushes after the peak attack involving a thickening of thin unattacked stems which then formed a larger proportion of the later samples. In due course, this 'new' wood can be attacked which would explain an increase in the late third year in the numbers of borers and galleries. Such an increase occurred but was small compared to the second year peak of attack. It was a notable feature shown in the data of six of the nine trials which experienced heavy attacks and ran for three years or more. The occurrence of this phenomenon is consistent with the theory that numbers of the borer are mainly dependent on the amount of suitable wood and that wood generally becomes less suitable as it ages. This new knowledge, however, brings about a partial revision of earlier ideas that, after a heavy second-year attack and decline, the numbers remain at a low ebb in the late third and fourth years of longer cycles. Evidently numbers can rise again, to a lesser degree, but one causing appreciable damage.

Data were reported previously (Cranham, 1964) showing that, with time after pruning, there was a progressive decline in the number of live inmates per open gallery and also in the proportion of young in the population, providing evidence that conditions in the wood become less suitable for borer development as the wood ages (possibly being less suitable for the growth of the ambrosia fungus). Re-examination of these results together with the third-year data now obtained shows that there was a levelling out of this decline in the third year.

TABLE 1.—*The ratio of immature stages (young) to adult beetles in the population of Shot-hole Borer; and the average number of all live borers per open gallery (data of* 1960-1963 *dieldrin trials).*

Months after pruning	Ratio of numbers Young/Adults		Average No. of borers per open gallery	
	Unsprayed plots	Sprayed plots	Unsprayed plots	Sprayed plots
7–8	1.82	2.40	5.29	3.64
9–12	1.77	1.74	4.40	4.27
13–16	1.78	1.56	4.79*	4.00
17–20	1.44	1.68**	4.31	4.96**
21–24	1.26	1.47***	2.98	4.24***
25–28	1.14	1.46***	2.74	3.83***
29–32	1.08	1.10	3.27	3.44
33–36	0.98	1.10**	3.10	3.30

N.B.—*The significance of Chi² for differences between the values for the sprayed and unsprayed plots within any period after pruning is shown by asterisks: *significant, **highly significant, ***very highly significant.*

In the data of Table 1, it will be noted that a decline in both ratios occurs on the sprayed plots where presumably it must be due to some feature in the aging of the wood rather than to accumulated attack. On the unsprayed plots, there was a marked decline in the two ratios over the period of peak attack (17th—28th months) in the late second and early third years, when it would appear to be due to accumulated attack; over these months the values for the sprayed plots are appreciably and significantly higher. In the late third year, the ratios for both the sprayed and unsprayed plots are more similar and appear to have stabilised, suggesting that at this stage the suitability of the wood on both sprayed and unsprayed plots is similar and largely dependent on the age of the wood after pruning. At this stage, too, the numbers of borers and galleries on both sprayed and unsprayed plots are on average very similar. The effects of spraying, so marked earlier, would appear to have expired.

2.2. *Yield trials*

(*a*) *Trials of randomised block design*

These three trials, at Hantane, Bandarapola, and Kirimetiya Estates were pruned after the first cycle of the trial in 1962, and the results of the first cycle have been reported previously (Cranham, 1963, 1964).

In the second cycle, in order to study the effect of borer control on the slope of the regression line of yield response on fertiliser dosage, two levels of N.P.K. fertiliser (T. 725 or T.750 mixtures) were introduced into each trial. These levels corresponded to 40 lb and 80 lb of nitrogen per acre per annum at Hantane and Kirimetiya, and 80 lb and 120 lb in the higher-yielding Bandarapola field.

The trials had run 18 months from pruning at Kirimetiya and Bandarapola in November 1963, and 15 months at Hantane in October, so that it is still early to look for the full response to fertilizer dosage, which may well be more marked towards the end of the cycle. Control of the borer is good on the sprayed plots in all three trials, and on the unsprayed plots so far the infestation at Hantane is comparable with that in the previous cycle; at Bandarapola it is a good deal heavier, and at Kirimetiya somewhat heavier than in the previous cycle.

(*b*) *Endane manurial trial*

This is a long-standing manurial trial of the Low-country Division a Endane Estate, Kahawatte, comparing nitrogen, phosphorus, potassium and magnesium, each at three levels, combined factorially in a 3^4 design with 81 plots in 9 blocks of 9 plots each, replicated twice, making 162 plots in all. The 18 blocks were used in 6 groups of 3 blocks each for the following treatments: (1) Dieldrin at 1.5 lb (6 pints 20% E.C.) in 10 gallons of water per acre applied by mist-blower after pruning; (2) a zinc sulphate foliage spray, and (3) control.

The trial completed a two-year cycle after dieldrin spraying (Nov. 1962) in October 1964. The results with respect to dieldrin spraying are of considerable interest. There was a 17% increase in yield on the dieldrin blocks over control, most of which occurred in the 18-24 month period after pruning; the degree of borer attack on the control blocks was only moderately heavy. There was a significant increase in yield on the nitrogen plots (40 and 80 lb N) as compared with the no-nitrogen plots, and correspondingly a significant increase in the number of borer galleries on the nitrogen plots as compared with the no-nitrogen plots. There was also a significant improvement in yield response due to nitrogen on the dieldrin blocks compared with the average for the non dieldrin blocks (zinc sulphate and control). In brief, this provides the first substantial evidence that nitrogen fertilizers can increase the yield *and* the borer attack, as judged by the number of galleries. Correspondingly, the evidence shows that, although there was a higher yield, there was a greater

percentage loss of crop due to the borer on the nitrogen plots, which presumably results from the greater degree of borer attack. The differences were relatively small but were significant.

(*c*) *Large-plot trials*

The trials at Rye (16/60) and Demodera (18/60) (Cranham, 1963a.), each with two dieldrin-sprayed plots and two unsprayed plots of about nine acres each, completed nearly three years from pruning in 1963. The Rye trial was pruned in Aug./September at 34 months; the Demodera trial continued on a four-year cycle into 1964.

The most notable feature of these two trials is that the increase in yield of the sprayed plots (over the yield of the unsprayed plots) was 26.4% at Rye, greater than the second-year increase of 18.6%, and 22.5% at Demodera, only a little smaller than the second-year increase of 25.4% (Table 2). This was so in spite of the fact that the sprayed plots suffered considerable reinfestation in the third year, to an extent that was roughly half or less than half that suffered earlier by the unsprayed plots, in which the infestation had now declined. In both trials the yield differences declined gradually throughout the third year but were still positively in favour of the sprayed plots even when they carried slightly more infestation than the unsprayed plots. This result is in marked contrast to that obtained in the first cycle of the Hantane (1/60) trial which showed a very close correlation between the yield increase and the difference in current infestation.

A re-examination of the data of these trials and others shows that the result at Hantane (Cranham, 1964) is the odd one out. It is in fact reasonable to suppose that crop losses, although greatest during peak infestation and attack, continue after this, declining gradually, because it takes time to repair the effect of shoot breakages and the debilitation caused by attack. In terms of yield increases due to borer control, we may expect benefits in the third year and possibly into the fourth year of longer cycles, and this in fact has occurred in several instances.

TABLE 2.—*Percentage yield increases in large plot trials, sprayed to unsprayed plots.*

Estate Trial	Present yield increase of Sprayed/Unsprayed (100%)		
	1st year	2nd year	3rd year
Rye (16/60)	10.6	18.6	26.4 (9 mths)
Demodera (18/60)	8.4	25.4	22.5
Halgolle	-3	15	—
Noori	-13	1	—
Wikiliya	8	28	—
Hunuwella	11	23	—

Apart from the above two trials, originally arranged under the supervision of T.R.I. staff (Judenko, Shanmugam and Hasselo, 1962) certain estates carried out trials of similar design on the lines suggested in our advisory leaflet of October, 1960 (Cranham, 1960). The results of four such trials are recorded in Table 2. With no more than duplicate plots it is always possible that, to start with, the plots to be sprayed may be higher-yielding or lower-yielding than the unsprayed plots. At Halgolle and Noori they were probably lower-yielding, judging from the first year comparison (–3% & –13%). However, if the yield of the sprayed plots improves steadily relative to the unsprayed plots into the second year, this is most likely due to borer control, provided other factors are equal. In fact, all four trials show this upward trend in the relative yield of the sprayed plots of an extent varying from 12% to 20% between first and second years of the cycle. These low-country fields suffered only moderately bad attack on the unsprayed plots.

(d) Estate experience

The final measure of the value of borer control lies in the practical experience of estates and to evaluate this it was decided to study results on several estates which had commenced spraying on a large scale in 1960-1961 (and in the case of one estate in 1958-59). Comparison was made of the annual yield after spraying with the yield in the two previous cycles, and where possible with the yield trend in unsprayed fields; borer sampling was also carried out to give some assessment of the degree of control obtained.

In many cases the data show the typical trend of yield increase shown in the plot trials *i.e.* by comparison with the previous cycle, a gradual increase into the second year of the cycle and, usually, some decline in the third year after the peak of borer attack. By comparison with the results of plot trials designed to evaluate the yield increase due to borer control alone, other factors being equal, the size of the increases on many estate fields have been greater; it seems likely that they are due not only to the direct effect of borer control but also to the indirect effects of removing the borer as a limiting factor (Gunn and Kanapathipillai, 1962), allowing the tea to respond better to increased fertiliser, and sometimes to other cultural changes, such as the removal of high shade and changes in time or type of pruning.

TABLE 3.—*Data on yields of estate fields after spraying with dieldrin for borer control. Comparison is made with the yield in the previous cycle before spraying, except in fields marked with the asterisk which have been sprayed over 2 cycles — here the comparison is made with the last cycle but one.*

Estate (fields)	Gain in yield on previous cycle (lb per acre) (percent comparison in brackets)			
	1st year	2nd year	3rd year	Cycle
Estate No. 1				
Field No. 1	−160 (−21)	712 (69)	580 (50)	1123 (38)
,, No. 2	−297 (−36)	846 (68)	988 (90)	1528 (48)
,, No. 3	−164 (−24)	771 (72)	766 (69)	1373 (48)
,, No. 4	− 74 (−13)	560 (53)	730 (81)	1216 (48)
,, No. 5	19 (3)	416 (46)	—	435 (29)
,, No. 6	579 (145)	805 (79)	—	1384 (98)
Estate No. 2				
Field No. 1	7 (1)	310 (54)	—	317 (31)
,, No. 2	16 (3)	242 (44)	—	258 (27)
,, No. 3	−21 (−5)	163 (15)	—	142 (9)
,, No. 4	188 (54)	446 (70)	—	634 (64)
,, No. 5	39 (16)	316 (60)	—	355 (46)
Estate No. 3				
Field No. 1	102 (12)	419 (34)	—	521 (25)
,, No. 2*	121 (25)	246 (44)	—	367 (36)
,, No. 3*	85 (12)	46 (6)	—	131 (9)
,, No. 4*	158 (28)	220 (25)	—	378 (27)
,, No. 5*	288 (43)	880 (126)	—	1168 (86)
,, No. 6*	474 (89)	678 (103)	—	1152 (97)
Estate No. 4 Field No. 1	−13 (−2)	549 (69)	—	536 (31)
Estate No. 5 Field No. 1	48 (19)	172 (52)	—	220 (38)
Estate No. 6 Field No. 1	68 (−5)	729 (33)	732 (40)	1760 (25)

TABLE 4.—*Data on yields of Estate No. 7 Fields after spraying with dieldrin for borer control*

Estate No. 7	Gain in yield on previous cycle (lb) (percent comparison in brackets)		
	1st year	2nd year	Total
Field No. 1	-94 (-11)	207 (18)	131 (6)
,, No. 2	5 (0)	342 (39)	347 (23)
,, No. 3	56 (13)	58 (6)	114 (8)
,, No. 4	35 (4)	158 (7)	193 (6)
,, No. 5	125 (12)	-129 (-7)	-3 (0)
,, No. 6	-46 (-5)	-34 (-2)	-80 (-3)

Tables 3 and 4 summarise the percentage yield increases obtained on fields of those estates so far studied. Estate No. 1 (in the Hali-Ela district) shows the most remarkable increase in yield varying from 29% to 98% over the cycle period. It will be noted that in the first year there was a lower yield in four out of the six fields; these fields were given a fairly hard pre-prune treatment when previously they had received a light prune or cut-across; the longer recovery period together with quite severe Tortrix trouble resulted in the lower first-year yields. This was much more than made up aferwards. Fields pruned in 1961, such as No. 6, were given a light cut-across prune; after dieldrin spraying these fields came away fast with greatly enhanced first-year yields. The average yield of this estate over the ten-year period 1951-1961 was around 900-1000 lb with fertiliser level around 100 lb nitrogen per annum. In 1962 the estate yield was 1463 lb and in 1963 nearly 1,700 lb. Fertilizer application has been increased proportionately, and the removal of high shade, and changes in pruning, have almost certainly been contributory factors. There can, however, be little real doubt that such yield increases could not have been achieved without the control of the borer as a key factor previously limiting yield.

The data of Table 3 illustrates that on Estate No. 2 (Kandy district) the general level of yield increases is also very striking. On this estate there had been, prior to the adoption of dieldrin spraying a general decline in yield and, in proportion, in the level of manuring. Dieldrin spraying has reversed this trend. In Estate No. 3 (Pussellawa district) Fields 2-6 are in the second cycle when dieldrin spraying has been carried out, and the percentage comparison has been made with the cycle before spraying started. Fields No. 5 and No. 6 were planted in 1949 and 1952 and the improvement in this younger tea is more marked than in the old tea of fields 1-4.

In Estate No. 7 (Pundaluoya district), except for Field No. 2 where there was a 23% increase, the effect on yield is much less marked than on the other estates. On three of the fields the yield had previously been declining. Dieldrin spraying has stopped this trend and there is a general improvement in the appearance of the tea. This example stresses the likelihood that in some cases there will be other important limiting factors to yield than borer attack which will need investigation. However, general reports on results suggest that a high proportion of the estates which have done large-scale spraying are achieving worth-while yield increases.

2.3. *Other points about dieldrin spraying*

Two replicated plot trials, sprayed in May 1961 on Lower B Field, Kataboola Group, were completed in 1963. Treatments in one trial (with plots of 200 bushes) included comparison of two dieldrin emulsifiable concentrates, a dieldrin 50% wettable powder, mixtures of lime (Limbux) with

dieldrin, and an experimental gamma-B.H.C. wettable powder ('Gamma-Cereclor' *ex* Messrs I.C.I. (Export) Ltd.). An attempt was also made to study the effect of spraying dieldrin on wet bark compared with spraying on dry bark by deliberate choice of wet and dry days. The results are summarised in Table 5.

In the second trial, adjacent to the other, plots of one-eighth acre were sprayed low-volume by motorised knapsack mist-blower with 'Dieldrex 20' E.C. at six pints and three pints in 10 gallons of water per acre. This was carried out deliberately on different replicated plots on wet and dry days in order to compare the effect. The results are summarised in Table 6.

The evidence of these trials, together with other evidence to be noted, leads to conclusions on the following points.

(*a*) *Efficacy of different formulations of dieldrin*

Both 'Dieldrex 20' and 'Dieldrex Extra' (*ex* The Shell Co. of Ceylon Ltd.) are emulsifiable concentrates containing 2 lb of technical dieldrin per Imperial gallon. . The latter formulation contains in addition a coumarone resin and was formulated orginally to give increased resistance to rainfall of spray treatments against the Rhinoceros Beetle on coconut palms (*Oryctes rhinoceros* L.) These formulations in the Lower B trial gave similar results at dosages of 3 pints and 6 pints/100 gal/acre and there was no evidence that the formulation with added resin ('Dieldrex Extra') gave a better duration of control.

In the various large-scale dieldrin trials, 1960-1963 series (See Section 2.1), some estates used ('Dieldrex 20'). The best results, and poorer results were obtained from both formulations. Thus, although here there was no precise comparison, there was no empirical evidence that the 'Dieldrex Extra' gave better results, not therefore that the extra cost of using it is justified.

In the Lower B trial, Dieldrex Wettable Powder at 4 lb and 2 lb/100 gal/acre (2 lb and 1 lb of dieldrin) gave similar results to the emulsifiable concentrates at 6 pints and 3 pints and would appear to be effective in practice. Previously we had no evidence that dieldrin wettable powders would give long-term control; it seemed likely that the emulsion would stand up better to weathering by rainfall. In this trial the wettable powder performed well in the high rainfall area of Kotmale. The wettable powder has been used on whole fields by a very few estates at 3 lb per acre (1.5 lb dieldrin, as in 6 pints of E.C.) with apparently good results. It is somewhat cheaper per lb of actual dieldrin and the need for a more precise comparison of the relative activity of the wettable powder and emulsion formulations is indicated.

TABLE 5.—*Kataboola Trial* (*Lower* B/1) — *Counts of galleries and infestation after spraying.*

TREATMENT	COUNT PER 100 UNITS					
	Galleries after (months):			Infestation after (months):		
	17	25	29	17	25	29
1. 'Dieldrex Extra' 6 pt.	7	24	54	9	64	84
2. 'Dieldrex Extra' 3 pt.	5	26	76	4	79	177
3. 'Dieldrex 20' 6 pt.	0	21	60	0	35	79
4. 'Dieldrex 20' 3 pt.	5	21	81	0	58	202
5. 'Dieldrex W.P.' 4 lb.	8	14	57	23	28	110
6. 'Dieldrex W.P.' 2 lb.	4	26	67	3	41	154
7. 'Dieldrex 20' 6 pt. plus lime	10	34	64	41	73	102
8. 'Dieldrex W.P. 4 lb plus lime	6	9	44	5	3	108
9. 'Cereclor' 8 lb	18	61	125	75	109	152
10. 'Cereclor' 4 lb	15	52	109	62	74	213
11. 'Dieldrex 20' 6 pt (WET BARK)	5	27	60	13	21	174
12. 'Dieldrex 20' 3 pt (WET BARK)	4	20	68	3	42	153
Unsprayed (Avg.)	34	84	82	116	134	112

N.B.—*Treatments* 11 *and* 12 *and the unsprayed area were not included within the trial design but were adjacent to it.*

(*b*) *Mixtures with lime*

Interest in the wettable powder is particularly focussed on mixtures with lime ('Limbux'). The practical advantage, apart from the use of lime for de-mossing, is as an aid to supervision of spray coverage. For this purpose, if de-mossing is not required, one-half hundredweight of lime per acre is probably sufficient.

In the Lower B trial the outstanding result was obtained from the mixture of 4 lb 'Dieldrex W.P.' with 1½ cwt of Limbux per acre; the count at the 25th month after spraying was significantly lower than the average of other dieldrin treatments in the trial, and was notably better than the mixture of 'Dieldrex 20' and Limbux. The mixture of emulsion with lime is also much less satisfactory with respect to physical compatibility—it forms a very thick, sticky mixture—which may account for the relatively poor result. The addition of the wettable powder to lime virtually does not alter the lime suspension so that it can be sprayed like lime alone.

At least one estate is known to have used this mixture of lime and dieldrin W.P. with good results. It would seem to have such particular advantages as to merit field-scale trial by estates.

(*c*) *Wet bark and rainfall*

In the Lower B trial an attempt was made to compare the effect of spraying on wet bark on a rainy day with the effect of spraying on dry bark on a sunny day. Excellent contrasting conditions occurred within a period of four days; treatments 1 to 10 (Table 1) were applied on absolutely dry bark on a brilliant sunny day. Treatments 11 and 12 were applied on wet bushes in light drizzle and it continued to rain for the rest of the day. Under these conditions we would have expected the effect of the dieldrin deposit and the subsequent effect to have been much reduced, but in fact the results obtained were very similar to those obtained with the dry treatments, and compare similarly with the unsprayed area.

The same result showed in the mist-blower plots (Table 6) where there was also no evidence that the dieldrin had a reduced effect on the 'wet' plots.

This result is in complete contrast to the previous evidence of Judenko's work (Judenko, 1960) which was the reason (together with empirical appraisal of the problem) for the stress laid on the need to spray on dry bark only (Cranham, 1961). At present, it would be rash to change this recommendation on the basis of these results alone; further investigations of this interesting aspect of spray application is planned.

(*d*) *Mist-blower applications*

In the Lower B mist-blower trial the control of the borer was similar to the control obtained in the high-volume trial; the comparison is not critical but the trials were adjacent in the same field.

TABLE 6.—*Kataboola Trial (Lower B/2) — mist-blower trial — counts of galleries and infestation after spraying*

DIELDRIN TREATMENT (BARK WET OR DRY)	COUNT FOR 100 UNITS					
	Galleries after (months):			Infestation after (months):		
	17	25	29	17	25	29
13. 6 pints (Dry)	3	15	68	1	25	129
14. 3 pints (Dry)	5	33	91	2	78	151
15. 6 pints (Wet)	7	26	66	11	47	136
16. 3 pints (Wet)	7	23	86	6	64	144
UNTREATED	34	84	112	82	116	134

In the Uva Ketawella No. 8 Field trial (1960-1963 dieldrin trials) the control on mist-blown and H.V. sprayed plots was also of a very similar order. On this estate, and on a few others most or all of the dieldrin spraying has been done by mist-blower. Fields have been sampled there and at Endane, Kahawatta, and the results appear to be about as good as is generally obtained from H.V. knaspsack spraying.

(*e*) *Trial design*

Part of the function of the Lower B trials was to determine whether trials of such design, with replicated small plots, can be of possible use in sorting out points concerning the long-term (*i.e.* at least second-year) effect of dieldrin sprays applied after pruning. It was feared that cross-infestation of the plots would obscure differences, and for this reason untreated plots were left out of the design.

In fact the trial shows significant differences between treatments up to such time as over-all reinfestation occurred. It is clear that such a trial cannot evaluate the duration of control from spraying any treatment on a whole field. Further it is likely that there is interaction between treatments, due to movement of infestation, that tends to reduce differences. It is clear, however, from the Lower B trials that such trials can show up larger differences between treatments, and be usefully employed to study certain aspects of the relative efficacy of treatments. It is felt that the trial design could usefully be modified to expose all plots more or less equally to reinfestation.

2.4. *Alternative insecticides*

(*a*) *Aldrin and Telodrin* (*isobenzan*)

The promising activity of these two insecticides was first shown in the Downside trial, reported previously (Cranham, 1964). An account of the work on them to the end of 1963 will be presented at the Biennial Conference in January, 1964 and published in the Tea Quarterly (Cranham, 1964).

The salient points in our present knowledge are as follows:—

1. Both aldrin and Telodrin give an excellent reduction of borer numbers within the first few weeks after spraying. At dosages which could cheapen the cost of control, the reduction is faster than from dieldrin and includes inmates within the galleries in a way that suggests that action of the insecticides in the vapour phase is appreciable (Downside and Drayton trials).

2. Telodrin is four or more times as active as dieldrin with respect to mortality over the first few weeks and up to 150 days after spraying, *i.e.* Telodrin is effective at dosages one-quarter or less those of dieldrin (Craigie Lea trial).

The relative activity of aldrin has not yet been worked out.

3. In the Carolina (Kadawella) No. 8 Field trial, 5-acre plots were sprayed with the three insecticides, spraying the basal frames of tea in the second year from pruning. The control obtained from all three insecticides was good and there was no appreciable reinfestation of any of the three treatments over a period of 10 months after spraying.

4. However, we have as yet no information on how these insecticides will compare with dieldrin for duration of control after post-pruning spraying. Because they give a good initial control it does not follow that they will give as good long-term control as dieldrin. We do not know how much the duration

of control obtained with dieldrin is dependent not only on the early kill but on long residual effects in relation to reinfestation.

(*b*) *Large plot trials with aldrin, Telodrin and dieldrin*

Since the duration of borer control and the Tortrix side-effect are influenced by the size of the sprayed area it is necessary to evaluate post-pruning sprays of aldrin and Telodrin on plots which approximate to whole fields in size. The series of 11 trials arranged during 1963 is similar to the 1960-1963 series of dieldrin trials on estates except that the plots are on average larger. The unsprayed control plots have been kept small in size, to minimise reinfestation within the fields, and because we are here concerned with comparison of three insecticides (and not, as in the dieldrin trials, in comparing sprayed and unsprayed).

With the co-operation of managements and superintendents, eleven trials were arranged which total over 500 acres of tea. On the same principle as the dieldrin trials, the spraying was done by the estates without special supervision by us as the principal object was to test the performance under estate conditions; the costs of treatment were borne from Institute funds. The trials are as follows:—Gallebodde, Galboda, Field No. 26 (35 acres); Carolina, Watawala, Field Kadawella No. 1 (51 acres); Hantane, Kandy (Fields No. 13 and 15 (47 and 34½ acres); Goorokoya, Nawalapitiya, Fields Nos. 19 and 20 (22 and 28 acres); and Fields Nos. 1 and 2 (20 and 24 acres); Ravenscraig, Nawalapitiya Fields Nos. 2 and 2A (20 and 23 acres); Meddecombra, Watagoda, Field Acramally No. 42A (52 Acres); Endane, Kahawatta, Field Madalagama No. 21 (42 acres); Downside, Welimada, Fields Nos. 7 and 7a (39 and 15 acres); Demodera, Demodera, Field Rossett No. 13 (43 acres); and Moolgama, Panwilatenna, Fields No. 1 and 7 (19 and 29½ acres).

Dosages involved are mostly aldrin and dieldrin 20% E.C.'s at 3 and 6 pints per 100 gallons per acre and Telodrin 15% E.C. at 2 and 4 pints per 100 gallons per acre.

None of the trials has run for much more than about one year as yet and they will only begin to yield information on the long-term effectiveness of aldrin and Telodrin by late 1964. Evaluation of these trials for the Tortrix side-effect is dealt with the section 3.1.

(*c*) *Work on aldrin residues*

Previous experiments have shown that dieldrin can safely be used as a post-pruning spray without danger of dieldrin residues in tea made from the tipping leaf or first plucking. Post-pruning sprays of aldrin and Telodrin, which are less presistent that dieldrin, can almost certainly be regarded as safe in this respect. Indeed, the very much lower persistence of aldrin may enable us to use it with a shorter minimum safe period between spraying and plucking. When spraying the basal frames of tea bushes with foliage some incidental contamination of the plucking table must be regarded as inevitable; in order therefore, to estimate the maximum risk we sprayed aldrin 20% E.C. at 4 pints and 8 pints per acre as a full foliage spray over the plucking table.

Leaf was plucked and manufactured at 0, 7, 14 and 21 days after spraying. Analyses of the made tea samples were carried out by courtesy of Shell International Chemical Co. Ltd. at the Shell Woodstock Agricultural Research Centre, England. The results are summarised in Table 7. A complication with aldrin is that a small part of the aldrin is epoxidised to dieldrin, which being much more persistent, is the main residue involved after a few days. Thus, samples plucked immediately after spraying contained residues consisting of

85% aldrin and 15% dieldrin, reflecting conversion to dieldrin prior to or during the manufacturing period; in samples plucked seven days after spraying, dieldrin comprised 80-90% of the much smaller residues after manufacture of the tea (See table 7).

TABLE 7.—*Date on aldrin and dieldrin residues in made tea, after aldrin spraying.*

Days after spraying	Dosage rate 'Aldrex 2' (pints/acre)	Mean residue found p.p.m.	
		Aldrin	Dieldrin
0	4 pints	6.5	1.2
0	8 pints	24	3.7
7	4 pints	0.72	2.6
7	8 pints	0.20	1.9
14	4 pints	<0.05	1.2
14	8 pints	<0.05	0.48
21	4 pints	<0.05	0.26
21	8 pints	<0.05	0.09

It can be seen from Table 7 that aldrin residues were negligible after 14 days. Dieldrin residues were very small although not negligible after 21 days. The total residues from the higher dosages rate fell more quickly that those from the lower dosage rate; possible explanations of this difference include a heavy fall of rain on the day the 8 pints/acre spraying was carried out, or perhaps, variations in the manufacturing process.

Despite the difference in rate of insecticide disappearance in this trial, it is clear that after aldrin spraying the persistence of aldrin and dieldrin residues on tea flush is comparatively short. Also, these residue levels occurred after full foliage spraying. We are concerned in practice with chance spray drift or accidental spraying of the flush when carrying out spraying of the basal frames. Hence on the present evidence it would appear that, after frame spraying, a minimum safe period of three weeks should give us an adequately large safety margin. This point will be checked in 1964 directly from frame spraying.

(*d*) *Use of aldrin in new clearings*

Although it has not yet been shown that aldrin will give a similar duration of control to dieldrin when sprayed after pruning on mature tea, we have found that in new clearings control will last for about a year, and in some cases longer. Since the treatment is relatively cheap on small plants, and carries little risk of Tortrix, it can readily be repeated after a year or two if required. Spraying need not follow pruning so long as the frames are accessible for spraying. If the clearing is in plucking a minimum safe period of three weeks between spraying and plucking is required.

A recommendation was given that planters can well try out aldrin in new clearings as an alternative to dieldrin. Details have since been given in an advisory leaflet and have been published in the Tea Quarterly (Cranham, 1964a).

(*e*) *Tests on other insecticides*

Over the past few years, trials against Shot-hole Borer have included tests on the insecticides listed in Table 8.

TABLE 8.—*Insecticides tested in various trials against Shot-hole Borer*

Insecticide (Common name)	Formulations tested	Dosage of active insecticide tested (lb per 100 gallons)
Gamma B.H.C. (lindane)	'Gammalin 20' (20% lindane E.C.)	1.5 lb.
	'Gamma Cereclor' (26% W.P.)	1 & 2 lb
Chlordane	'Clordox' (100% E.C.)	1.9 – 20.8 lb
D.D.T.	'Didimac 25' (25% E.C.)	3¾ lb & 7½ lb
carbaryl	'Sevin' 50% W.P.	1½ & 3 lb
endrin	'Endrex 20' (20% E.C.)	0.75 & 1.5 lb
endosulfan	'Thiodan' 35% E.C.	0.875 & 1.75 lb

1. Gamma—B.H.C. or lindane: the first formulation, 'Gammalin 20' was included in trials at Imboolpittia and Aislaby estates; results were poor and work was afterwards concentrated on the 'Gamma-Cereclor' wettable powder, an experimental formulation designed to give extra persistence. this was included in the replicated trials at Kataboola Lower B and Downside estates, as well as in larger-scale trials at Sanquhar and Demodera Group. It was apparent from the Downside trial that this formulation did not give a good initial reduction of borer numbers comparable to aldrin, dieldrin or Telodrin, so that one could hardly expect a good long-term result. This in fact has been borne out in the Demodera and Kataboola trials.

2. Chlordane was tested at a wide range of doses by Judenko (1960) who reported that at dosages of the same cost Chlordane was markedly inferior to dieldrin; this implies that the control from 5 lb of chlordane was inferior to that obtained from 1.5 lb of dieldrin.

3. DDT was included at high dosages in one Aislaby trial in 1960. At 7.5 lb per acre it gave about 70% reduction within the first ten weeks after spraying but this was markedly inferior to dieldrin at the 1.5 lb dosage.

4. Carbaryl (Sevin) which has been reported as effective against some scolytids, was included as a 50% wettable powder in the same Aislaby trial at 1.5 and 3 lb carbaryl per acre. There was no significant reduction in numbers within the first ten weeks.

5. Endrin was included in the Downside trial at the same dosages as aldrin and dieldrin i.e. 0.75 and 1.5 lb per acre. It gave a significant reduction in borer numbers over the first eight weeks, but the result was markedly inferior to aldrin, dieldrin and Telodrin.

6. Endosulfan (Thiodan) was included in the Downside trial at 1.75 and 0.88 lb of endosulfan per acre and gave no significant control.

During 1963, it was decided to investigate what activity might be shown by a range of the less toxic organo-phosphorous insecticides. A trial was arranged on a new clearing at Drayton Estate to include dieldrin as a standard control. Parathion was included to check the activity of one of the most toxic but most active compounds in the organo-phosphorous group. The other compounds chosen for test fall within the intermediate or lowest class as regards mammalian toxicity.

1. Malathion as a 50% E.C.

2. Fenitrothion ('Sumithion') as a 50% E.C. ex Messrs Sumitomo Chemical Co. Ltd. of Japan. This compound is also available from Messrs Bayer Leverkusen W. Germany, designated 'Folithion' or Bayer 41831.

3. Fenthion, (0, 0 – Dimethyl 0 – (4) (methylthio) – m tolyl) phosphorothioate), as a 50% E.C. *ex* Bayer Leverkusen, W. Germany.

4. Dichlorvos (0, 0 – dimethyl – 2, 2 – dichlorovinyl phosphate) as a 20% E.C. ('Marvex 20') *ex* Messrs Bharat Pulverising Mills Private Ltd. Bombay, India.

5. Naled as a 96% E.C., 'Ortho-Dibrom 8' *ex* The Californian Spray Chemical Corporation, U.S.A.

The counts obtained in this trial before treatment and 2, 4, 8 and 12 weeks after spraying are recorded in Table 9.

TABLE 9.—*Results of Drayton trial on activity of various organophosphorous insecticides against Shot-hole Borer*

Insecticide, dosage rate of active insecticide per acre.	Number of adult borers (young stages in brackets) after (weeks):				
	Precount	2 wk.	4 wk.	8 wk.	12 wk.
dieldrin,† 1.5 lb	32 (67)	10 (43)	5 (26)	12 (7)	5 (10)
fenitrothion, 2.51 lb	35 (149)	24 (85)	15 (8)	13 (21)	23 (86)
malathion, 2.5 lb	35 (128)	25 (108)	58 (155)	29 (54)	49 (178)
naled, 2.4 lb	20 (47)	41 (65)	45 (129)	26 (62)	42 (100)
fenthion, 2.5 lb	25 (105)	20 (63)	12 (49)	17 (17)	21 (57)
dichlorvos, lb	37 (127)	51 (177)	43 (55)	37 (82)	49 (85)
parathion, 0.6 lb	23 (63)	26 (80)	27 (75)	31 (92)	27 (59)
untreated Control	72 (159)	56 (112)	28 (30)	28 (33)	18 (45)

† *included as standard.*

It appears that fenitrothion gave a very marked reduction of the numbers of young after 4 weeks but that the plots (of 100 bushes) became reinfested again by 12 weeks after spraying, presumably because there was no persistent effect as with dieldrin. The activity of this compound should be worth investigating further. Of the other insecticides, only fenthion showed a significant reduction after 8 weeks but numbers had increased again after 12 weeks.

3. Tea Tortrix

3.1. *Large-scale trials of aldrin, Telodrin and dieldrin*

The series of large-scale trials started between October 1962 and October 1963 (*see* Section 2.4. (*b*)) provided the opportunity to assess the Tortrix side-effect of aldrin and of Telodrin relative to that of dieldrin.

It was only possible to assess the numbers of Tortrix per 100 bushes in a few of the trials. In the other trials, a collection of Tortrix larvae was made in order to assess the percentage parasitism by *Macrocentrus homonae* and in all trials the degree of Tortrix damage was assessed visually using the following categories.

1. Very light damage—a few Tortrix nests to be seen on a small percentage of the bushes after some searching.

2. Light damage—Tortrix nests easily spotted without searching, few per bush and not on most bushes.

3. Moderate damage—Tortrix nests several per bush, on most bushes, but damage not severe enough seriously to hinder recovery from pruning. On tea in plucking, some depression of crop and the plucking table ragged in patches.

4. Heavy damage—damage on nearly all the bushes, and on some bushes severe enough to seriously hinder recovery from pruning or seriously to effect crop on tea in plucking.

5. Very heavy damage—severe defoliation widespread; recovery from pruning stopped, or fields in plucking out of production.

These categories of damage are referred to by the above numbers 1 to 5.

For the purpose of judging the relative Tortrix attack on the various insecticide plots we withheld spraying with DDT or Dipterex until it clearly had to be done to prevent heavy damage from developing or continuing. Usually, damage reached levels 3 to 4 before spraying was done; whereas in estate practice spraying would best be carried out routinely after dieldrin or as soon as the development of moderate damage (3) is apparent.

TABLE 10.—*Large-scale trials with aldrin, dieldrin and Telodrin: categories of Tortrix damage on the different plots*

Trial No. Estate	Dieldrin		Aldrin		Telodrin		Unsprayed
	6 pt.	3 pt.	6 pt.	3 pt.	4 pt.	2 pt.	
1. Gallebodde	4††	—	4††	—	4††	—	3–4†
2. Carolina	3–4†	—	4††	—	—	—	3–4††
3. Hantane	3–4†	—	0	—	0	—	0
4. Goorokoya	3–4†	3–4†	2	2	—	—	1–2
5. Ravenscraig	4–5†	4–5†	—	—	3–4†	2–3	1
6. Meddecombra	—	4†	2–3	2–3	3	4†	1
7. Endane	3†	—	2	—	—	—	1
8. Downside	2–3†	2–3†	1	1	1	1	1
9. Goorokoya	3–4††	3†	—	—	3†	3†	1–2
10. Demodera	2–3	2	2	2	—	—	2
11. Moolgama	3–4††	3–4††	—	—	3–4††	3†	3–4†

† *sprayed once*
†† *sprayed twice*

The damage categories recorded in the different plots are given in Table 10. All eleven trials contained dieldrin plots at the dosages of 6 pints or 3 pints or both, and in all except one trial (No. 11) it was necessary to spray these plots. In two of the trials, spraying had to be repeated. Damage was not appreciably less on the plots which received the 3 pint dosage than on the 6-pint dosage plots.

Attacks on the aldrin plots were in most trials very much less severe than on the dieldrin plots. With Trials 1 and 3 the incidence of Tortrix was high generally in the district, and the parasite and other natural control factors could not prevent serious attack on the unsprayed plots. Under these conditions serious attack occurred also on the aldrin plots and it was necessary to spray all the plots twice (except the dieldrin plot in Trial No. 3). In the six other trials with aldrin plots, the attack on the unsprayed plots was either absent (No.4), very light (No's 7, 8, 9 and 11) or light (No. 5), and wherever this occurred the attack on the aldrin plots was generally in the same category or only a little

heavier. In these six trials it was not necessary to spray the aldrin plots; in Trial No. 7 only, the damage reached levels 2-3, mainly it appeared because of cross-infestation from the adjacent dieldrin and Telodrin plots.

Seven of the trials contained plots sprayed with Telodrin, and in two of these (No.'s 1 and 12) Tortrix attack was heavy even on the unsprayed plots, as well as on the dieldrin and Telodrin plots, so that all were sprayed. The Telodrin plots were sprayed, or part was sprayed, in three out of the other five trials. In Trials No. 4 and No. 9 the attack on the Telodrin plots (4 pint dosage) was negligible, when the attack on the dieldrin plots was moderately heavy. In general there was some evidence that Telodrin, especially at the 2-pint dosage, was somewhat less liable than dieldrin to produce severe attacks.

The data on parasitism provide further useful information. It is clear that aldrin does not interfere with the parasite nearly so drastically as dieldrin and permits an earlier recovery of parasite numbers. Telodrin was intermediate in effect between aldrin and dieldrin, although the effect was generally closer to that of dieldrin. There was some evidence that Telodrin at the 2-pint dosage had considerably less effect on the parasite than 6 pints of dieldrin.

3.2. *Estate experience on chemical control*

Dipterex, recommended previously as an alternative to DDT for control of Tortrix (Cranham, 1962) was in use by many estates and generally gave fairly good results in Tortrix control. It was borne out in estate practice that it has the advantage of not stimulating mite outbreaks. There were a number of reports of failure to obtain adequate control with Dipterex when it was applied low-volume through a mist-blower, especially on low-jat tea. There were a few such reports about high-volume knapsack spraying usually after use of the 1 lb per acre dosage.

In the result, recommendations were partly revised. Dipterex was recommended at the full rate of 2 lb per acre in 50-60 gallons of water applied by knapsack sprayers and not recommended for mist-blowing. Carbaryl, (Sevin), which had been cleared in a further taint trial, was recommended for field-scale trial by estates. The revised recommendations were circularised to all estates (Ento. Advisory leaflet 1964/1).

In the long run it is hoped to devise chemical control of Shot-hole Borer that will produce much less trouble with Tortrix. It is probable too that improvements can be made in the chemical control of Tortrix, and further work is planned.

4. Mites

4.1. *The effect of insecticides on mite numbers*

Trials carried out during 1961 and 1962 to assess the effect of different insecticides on mite numbers have been reported previously (Cranham, 1962, 1963). A further randomised block trial was carried out on St Coombs in 1963; spraying was done in December 1962 and repeated in February 1963, and monthly counts carried out from January to June 1963. The numbers of Scarlet Mite were adequate for the purpose of the trial, but once again the numbers of Red Spider Mite were very low.

TABLE 11.—*St Coombs* (1963) *trial: the effect of insecticides on Scarlet Mite numbers.*

Insecticide (lb active per acre)	Mean* No. of Scarlet Mites per 100 leaves (600 counted) after (months):						
	0 Dec.	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May	6 June
DDT 1.5 lb	474	442	608	838	1390	762*	328*
carbaryl 1.7 lb	410	798*	778*	1320*	1920*	504	114
'Dipterex' 1.6 lb	508	612	644	1234*	406	398	138
aldrin 1.5 lb	478	482	446	618	644	314	76
'Telodrin' 0.56 lb	360	728*	606	940	1116	344	104
'Perthane' 1.25 lb	546	236*	234*	238*	488	358	246
Untreated (Avg)	406	458	476	620	856	546	134

N.B.—*Analysis of variance on log* $(n+1)$ *values. Counts asterisked are significantly different* ($P=0.05$ *from the untreated control average.*

The data for Scarlet Mite is given in Table II. Thee was no doubt in this trial of the result from carbaryl (Sevin), as there had been in the 1962 trial; the carbaryl plots carried significantly more mites in months 1-4 after spraying. The effect of DDT was also significant but much slower to develop; in the 1962 trial the increase was significant after 3-4 months whereas in this trial the effect was possibly present in the 4th month but was significant only in the 5th and 6th months when in fact there was a general decline in the population.

'Dipterex' produced a significant increase in March, three months after spraying. The counts on the 'Perthane' plots for the three months after spraying were significantly lower than the untreated. These results with 'Dipterex' and 'Perthane' are quite at variance with the 1962 trial whereas the results from DDT and carbaryl (Sevin) are in general agreement. As before, the increases represent only slightly more than a doubling of mite numbers which could hardly be expected to cause serious outbreaks. It is possible that under some circumstances the effect is more pronounced.

With Red Spider Mite, DDT was again the only insecticide to give a significant increase on the low numbers which occurred. Four months after spraying the count was 126 mites per 100 leaves against an average of 18 on the untreated plots. Although the numbers are low the increase is seven-fold and thus could be of greater practical importance than the result with Scarlet Mite. In fact in practice, outbreaks of Red Spider Mite after DDT spraying are more of a problem than outbreaks of Scarlet Mite, although the latter have been noted. The other treatments gave no signs at all of a tendency to increase Red Spider Mite.

Publications

CRANHAM, J. E. (1963). Shot-hole Borer: Biology and Control. Notes for planters, 1963. *Tea Quart.* **34,** 127-143.

Acknowledgements

A great deal of help from the superintendents of estates and from Colombo agencies, particularly in connection with the initiation of large-scale trials on aldrin and Teodrin, is most gratefully acknowledged.

The Technologist, T.R.I., co-operated on the manufacture of samples of made tea for taint and residue tests.

Thanks are again due to Messrs Shell International Chemical Co. Ltd. for analysis of tea samples and for permission to quote results on aldrin, and to Messrs Bayer Leverkusen, W. Germany for further analyses of tea samples for Dipterex residues.

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REPORT OF RESEARCH OFFICER, ENTOMOLOGY UNIT, HANTANE SUB-STATION FOR 1963

D. Calnaido, B.Sc., Ph.D.

General

Attention was concentrated on organizing and developing an entomological laboratory at Hantane Sub-station. This involved getting the laboratory up to requirements as regards building, equipment, assistants, and laboratory facilities, including electricity.

Staff

The entomology staff consisted of Mr A. Rajendra (Technical Assistant), Messrs J. Bandaranayake, R. S. S. Fernando (Field Assistants) and myself. Mr A. Rajendra resigned as from the 30th November, 1963 and Mr K. Thirugnanasuntharan was appointed to take his place.

1. The Ecology of Shot-hole Borer

The main line of work dealt with extensive and intensive research on several aspects of the biology, behaviour and dipersal of Shot-hole Borer. New techniques, involving the use of Johnson suction traps, were employed in experiments designed to study the problem.

1.1. *Studies on the abundance and distribution of* Xyleborus fornicatus *Eichh. in relation to pruning date and the growth of tea throughout the pruning cycle.*

A vertical series of suction traps, at heights of 0′ (ground level), 3′ (crop level), 6′, 9′, 22′ and 45′ was erected to sample the terrestrial and aerial population of a tea field (Field No. 7.G, Hantane Estate, Kandy). This experiment, designed to study the phenology (pattern of distribution in relation to time and climatic factors) of the borer, its flight and dispersal, is in progress. The data that have so far been collected promise valuable information from this experiment.

1.2. *Diurnal flight periodicity of adult* Xyleborus fornicatus.

The pattern of the daily flight of the borer was worked out by hourly sampling with suction traps. The males are wingless and hence flightless. The female borers fly for only 7 hours of the day, and there is no flight by night. Flight commences at 9 a.m. and increases until at 12-00 noon—13.00 hours when maximum numbers are in flight. From then on flight decreases and ceases altogether at 16.00 hours. Approximately 40% of the total daily flight is at 12.00 to 13.00 hours, C.S.T.

1.3. *The diurnal periodicity of emergence of* Xyleborus fornicatus.

The pattern of daily emergence of beetles from galleries in tea stems was worked out by the "bagged method" (Calnaido, 1964). Borers were found to have a daily pattern of emergence similar to the pattern of flight, which would indicate that most beetles come out of their galleries to disperse. However this relationship has yet to be confirmed by other investigations now in hand.

1.4. *The condition of flight muscles of* Xyleborus fornicatus.

The condition of flight muscles in the beetles caught in flight (in the suction-traps) compared with those that had 'emerged' from the galleries in tea stems, and those that had not 'emerged' from galleries, was investigated by dissection of the beetles.

The data collected to date show that all beetles caught in flight had well-developed flight muscles and those that 'emerged' from the galleries had flight muscles developed to various degrees while approximately 90% of those that had not 'emerged' from the galleries had degenerate flight muscles. It is also of interest that development of ovaries showed the opposite trend to that of the flight muscle condition; in those beetles caught in flight the ovaries showed a negligible stage of development and in beetles that did not 'emerge' from the galleries the ovaries were fully developed, while beetles that 'emerged' from galleries in tea stems showed intermediate degrees of ovary development.

As this aspect of the problem has direct bearing on the dispersal of the borer, studies are in progress to investigate whether *Xyleborus fornicatus* behaves like some other members of the family Scolytidae, which are known to autolyse their wing muscles in flight (Chapman, 1958).

1.5. *The dispersal of* Xyleborus fornicatus.

Tentative estimates of the terrestrial population of the borers per acre of tea were worked out. (For Field No. 9 Hantane Estate, Kandy, in its 27th—29th month from the pruning date). This gave evidence that large numbers of female borers (of the order of 1,300 to 1,900 borers per acre per day) left the tea field. Corresponding studies (with the aid of the vertical series of suction traps), on the aerial population of an adjoining tea field (No. 7.G), indicated that there was a cyclic movement of this aerial population of borers, where the borers dispersed into the upper air around mid-day and settled down again by the afternoon (Calnaido, 1964).

The above evidence indicated that *Xyleborus fornicatus* had wide powers of dispersal, similar to, but at a lesser rate, than Aphids and Frit-fly (Johnson 1957b and Johnson *et al*, 1962).

In view of this aerial dispersal of Shot-hole Borer and the possible effects on the recolonization and reinfestation of tea fields, it is considered advisable for estates to make a combined effort in the chemical control of Shot-hole Borer and to protect young tea by timed chemical control.

2. Studies on the Reinfestation of a sprayed Tea Field by Xyleborus Fornicatus.

2.1. A tea field (No. 7.G Hantane Estate, Kandy, in its 8th month from the pruning date) was sprayed with dieldrin 20% E.C. 'Dieldrex 20' at the rate of 6 pints in 80 gallons of water by knapsack sprayers (Cranham *et al*, 1962). Only the lower frames of the bushes were sprayed and the plucked leaf was discarded for a period of six weeks from the date of spraying.

The mode and pattern of reinfestation of this sprayed field are being studied. The growth of both the terrestrial and aerial population of this field and the adjoining unsprayed field (No. 7. F) are being recorded for comparative study. The aerial population is being recorded with the aid of two 9" Vent-axia suction traps, one in the centre of 7. G (unsprayed) and the other in the centre of Field 7. F (sprayed).Both traps are run at crop level. The terrestrial population (the population within the crop) of the same two fields are being studied by the standard unit method (Judenko, 1958).

This experiment has now run for a period of one year and the results are very encouraging, but another year's work is necessary before any conclusions can be drawn from these findings.

2.2. *Line sampling with the standard unit method to investigate "edge-effect" in infestation.*

Several transections or lines of sampling the tea bushes, taking 50 standard units from groups of 5 × 5 tea bushes, are being made from the border of field No. 7. F (unsprayed) and No. 7. G (sprayed) to the centre of these two fields, to study whether there is any "edge-effect" in infestation (progressive infestation of the sprayed field from its edges, bordering the unsprayed field).

3. Suction Trap collections of insects in a Tea Field

The suction traps, which were erected to study the aerial population of Shot-hole Borer, also enabled comparative population studies of other insects in tea. Hence, the opportunity is being used to gather information not only on Shot-hole Borer and other Scolytids but also on other insects in tea, especially the Tea Tortrix moth and the *Macrocentrus* parasite.

3.1. *Family Scolytidae*

The relative abundance and distribution of *Xyleborus fornicatus* and other species of Scolytidae are being studied with the use of the suction-traps. Of a total of over 15,000 beetles, of 33 identified species of the family Scolytidae, caught in the suction-traps, over 90% belonged to the genus *Xyleborus*. And of approximately 14,000 beetles, of 15 identified species of the genus *Xyleborus*, only 25% belonged to the species *X.fornicatus*. As far as possible records of daily catches of many species of Soclytidae are maintained with a view to developing some contribution to our knowledge of the "Scolytidae of Ceylon".

3.2. *Identification and collection*

Beetles collected from the suction-traps and from galleries in tea stems were sent to Prof. K. E. Schedl, in Austria, for identification. Named specimens of the identified species, 33 species of the family Scolytidae and 15 species of the genus *Xyleborus*, received from Prof. Schedl have been added to our collection.

3.3. *The abundance and distribution of the Tea Tortrix moth and the* Macrocentrus *parasite, in relation to that of Shot-hole Borer.*

With the aid of the same series of suction-traps, daily records of counts of the Tea Tortrix moth and the *Macrocentrus* parasite are being maintained to work out their population dynamics, in comparison with that of *Xyleborus fornicatus*. Comparative population studies on these three insects are being made with a view to ascertain whether it would be possible to regulate chemical control in order to have maximum benefit from natural or biological control.

3.4. *Diurnal flight periodicity of insects in tea*

The hourly catches of all other insects caught in the suction-traps are collected and preserved so that an analysis and a comparative account of the "diurnal flight periodicity of insects in tea" could be made.

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REPORT OF THE ADVISER IN NEMATOLOGY FOR 1963

A. Kerr, Ph.D.

Staff

Following the withdrawal of U.S. Aid from Ceylon, Dr M. T. Hutchinson left the Institute on 31st March. Dr N. Shanmuganathan was appointed Acting Nematologist and was in charge of the Department until I took up my appointment on 11th September. There were no other staff changes.

General

No advisory visits were made during the year. One hundred and seven letters were received and 108 sent. The work described in this report was originated by Dr Hutchinson and, in the later stages, supervised by Dr Shanmuganathan.

1. Pratylenchus Loosi—the meadow nematode

1.1. *Resistance and Tolerance of Tea Clones.*—A second test was carried out for the evaluation of tea clones for resistance and tolerance to *P. loosi.* The design of the experiment was the same as that for the first test in 1962, and involved growing 16 test clones and two control clones in soil heavily infested with nematodes from 25 estates. There were four blocks of infested soil and half of each block was fumigated with D.D. and half untreated. In each half block there were four replicates of each clone, making sixteen replicates of each clone grown in untreated soil and 16 in fumigated soil. The control clones were DT 95, a standard resistant clone, and TRI 2024, a standard susceptible clone. The test clones were CH 33, DK 1, DK 14, DK 17, DR 12, GMT 9, M 114, M 116, M 146, M 208, M 209, M 241, W 3, TRI 2027, TRI 2117 and TRI 2151.

Final results are not yet available but visual observation indicates that clones DK 1, MO 116 and MO 146 have appreciable resistance or tolerance, but none grew as well as DT 95 in the infested soil. None of the other clones performed well in the test.

The tests are designed to select only those clones with a high level of resistance or tolerance. The conditions of the test are much more severe than would ever be encountered in the field and it is possible that clones which grow poorly under the test conditions, might grow well in infested fields. There is some evidence that clones DT 1 and K 145, both tested in 1962, fall in this category.

Field trials on four estates will be laid down in 1964 with clones DT 1, MO 116, M 208, MO 241, TRI 2025 and TRI 2142.

1.2. *Nematode Population Trends in Clones DT 95 and TRI 2024.*—Two clones, one resistant (DT 95), and the other susceptible (TRI 2024) to *P. loosi* were inoculated with nematodes from Chapelton and Wootton estates. The numbers of nematodes in the roots of the two clones were measured every 3 weeks for more than 6 months. Results are given in Fig. 1.

There was a rapid build up of nematodes in the roots of clone TRI 2024 and a much slower and less regular increase, in the roots of DT 95. The results indicate that the resistance of clone DT 95 to *P. loosi* is associated with, and is probably caused by, some factor in the roots which restricts the multiplication of the nematode. There was no significant difference in the response of either clone to nematodes from the two estates.

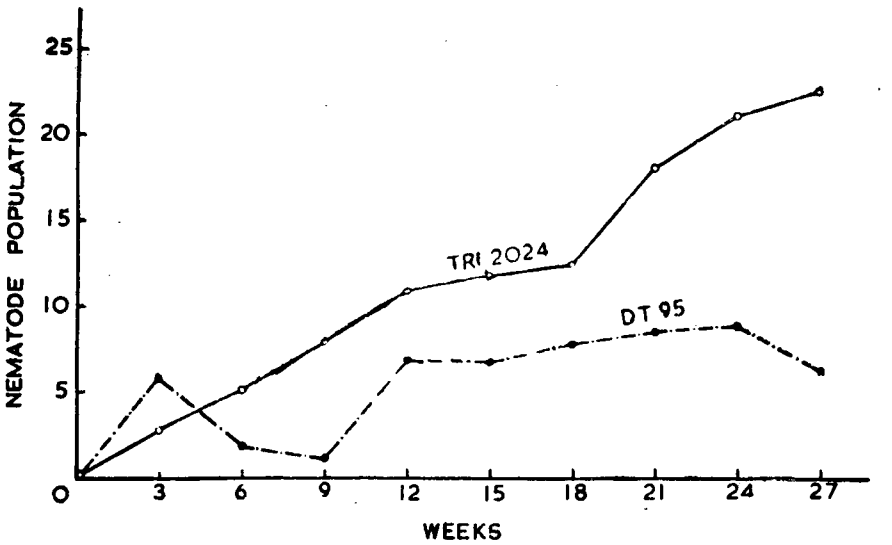

Figure 1 — Nematode population (log transformed data) in the roots of a resistant clone (DT 95) and a susceptible clone (TRI 2024) following inoculation with *P. loosi*

1.3. *Rehabilitation Test.*—A pot experiment was designed to determine how long *P. loosi* survives in soil under different treatments. One hundred and twenty concrete pots were filled with Guatemala grass soil which was inoculated with heavily infested soil and infected roots, 300 g. soil and 100 g. roots being added to each pot. The treatments were: (1) sown with marigold (2) planted with Guatemala grass, (3) planted with tea and (4) left fallow, and each treatment was applied to 30 pots. The treatments were continued for 2, 3, 4, 6, 8 and 10 months (5 pots for each period) and survival of nematodes was determined by planting tea in the treated soils and counting the number of nematodes in the roots after 2 months. Results are given in Fig. 2.

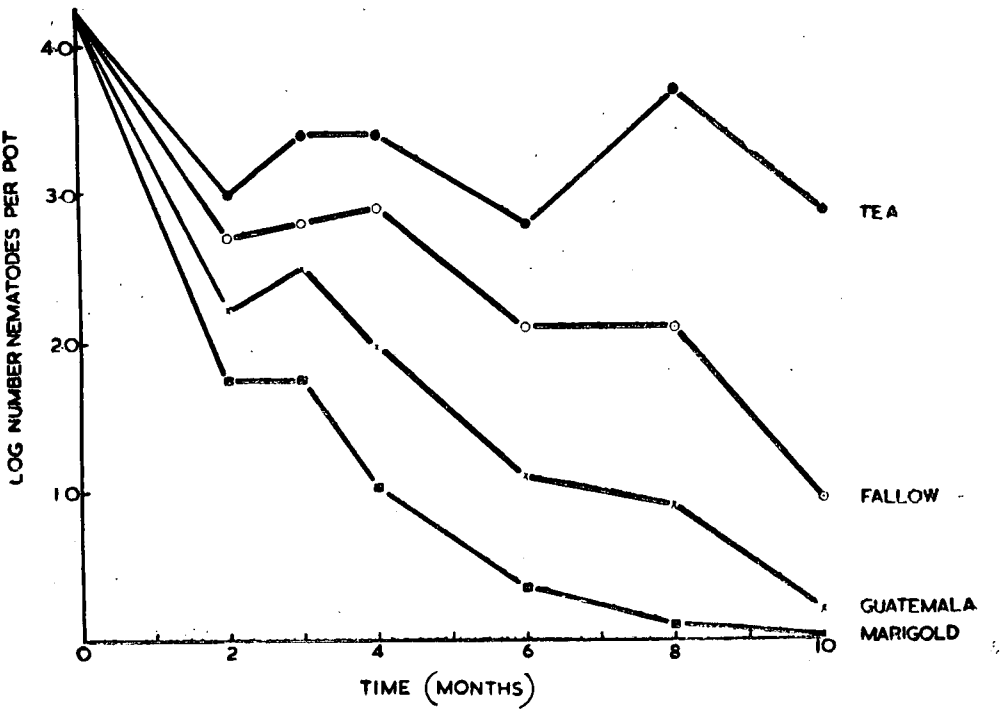

Figure 2—Survival of *P. loosi* under different crops.

Survival of nematodes was least in soil under marigolds, followed by Guatemala grass, then by fallow and was highest under tea. Differences between all treatments were significant ($P < 0.01$).

Under the carefully controlled conditions of the experiment, *P. loosi* survived for between 8 and 10 months in soil under marigolds, and nematodes had not been eliminated from soil under Guatemala grass in 10 months. This indicates that a longer period of rehabilitation is necessary for the elimination of nematodes in the field. The relatively high survival rate of nematodes in fallow soil suggests that both marigolds and Guatemala grass exert an active influence on the survival of nematodes, and not merely a passive one through starvation.

Studies have been initiated to determine the survival of nematodes in the field over rehabilitation periods of 12-24 months. On one area of St Coombs the nematode population was 37 per 100 g. soil immediately after uprooting, and after 7 months rehabilitation with a mixture of Guatemala grass and marigolds, the population was 5 per 100 g. soil. Many tea roots, several of them well over 1 in. in diameter, were left in the soil after uprooting and after 7 months, live nematodes were still present in root lesions. The importance of removing all tea roots over 1 in. in diameter cannot be over emphasized.

1.4. *Host Range of P. loosi.*—A second series of plants was tested for susceptibility to *P. loosi*. The method of testing was the same as that used by Hutchinson (1963). Isolates of *P. loosi* from at least 4 different estates were used. Results are given in Table 1.

TABLE 1.—*Susceptibility of various plants to P. loosi*

Plant	Wt of roots (g)	No. of Nematodes	Nematodes per g. root
Flemingia congesta	425.4	0	0.0
Oxalis corymbosa	24.3	0	0.0
Drymaria cordata	227.6	2	0.0
Tithonia diversifolia	1010.8	4	0.0
Crotalaria brownei	1914.1	33	0.0
Tecoma stans	1460.8	67	0.0
Crotalaria usaramoensis	608.9	33	0.1
Grevillea robusta	325.4	33	0.1
Desmodium gyroides	88.4	31	0.4
Gliricidia maculata	306.5	233	0.8
Oxalis latifolia	53.8	100	1.9
Coffee	54.4	209	3.8
Albizzia moluccana	228.3	1110	4.9
Indigofera endecaphylla	149.8	1057	7.1
Sesbania cinerascens	1505.7	14599	9.7
Tephrosia vogelii	974.9	80433	82.4
Potato	16.5	2031	123.1
Tea	17.0	11699	688.2

As in previous studies, tea proved to be the most susceptible plant tested, but potato and *Tephrosia vogelii* both supported large populations of *P. loosi*, again confirming previous results. *Albizzia moluccana, Indigofera endecaphylla* and *Sesbania cinerascens* must also be considered susceptible. None of the susceptible plants should be used during the rehabilitation period, or in the establishment of young tea. This would condemn *Tephrosia vogelii, Sesbania cinerascens* and *Indigofera endecaphylla* as cover crops on estates above 3,000 feet where *P. loosi* is present. If potatoes are grown during the rehabilitation period, they must be followed by Guatemala grass for sufficient time to eliminate *P. loosi*.

1.5. *Marigold Field Trial.*—A previous experiment (Hutchinson, 1963) has shown that sowing marigolds between rows of infected tea shortly after pruning, resulted in a yield increase. Further experiments have been laid down on Logie and St Coombs estates. A "paired plot" design was used on both estates, one of each pair of plots being sown with marigolds and the other untreated. On Logie, seedling tea was interplanted on 11th November, 1962 and on St Coombs, clone TRI 2024 was interplanted on 23rd September, 1962. Yields have been recorded weekly since 14th March, 1963 on Logie and since 29th January, 1963, on St Coombs. Both experiments are continuing, but results to date are given in Table 2.

TABLE 2.—*Effect of planting marigolds between tea infected with* **P. loosi**

	Mean yield per plot (lbs green leaf)	
	Logie (42 plucks)	St Coombs (48 plucks)
Untreated	79.4	61.3
Marigold	83.6	70.6
% Increase	5%	15%*

*Significant at $P < 0.05$.

On St Coombs, the yield of the marigold plots was significantly higher than the untreated plots ($P < 0.05$), while on Logie the difference was not significant.

We now have data from three field experiments involving interplanting infected tea with marigold. All show an increase in yield as a result of interplanting. Two further experiments on St Coombs estate have been laid down.

1.6. *Treatment of Infested Soil with Marigold Root Extracts and α-terthienyl.*—α-terthienyl is one of the chemicals in marigold roots toxic to nematodes(Uhlenbroek and Bijloo, 1958). A sample of α-terthienyl was dissolved in petroleum ether to give a 0.25% solution. Five ml. of this solution were added to 395 ml water and emulsified using teepol. Twenty five grams of marigold roots were macerated with 400 ml water, filtered through a fine sieve and the filtrate made up to 400 ml.

Naturally-infested soil was added to polythene bags and each bag treated with α-terthienyl emulsion, petroleum ether emulsion, filtrate from young marigold roots (8 weeks old), filtrate from old marigold roots (20 weeks old) or with water. Four hundred ml were added to each bag and there were 9 replicates of each treatment. The treated bags were placed in 9 randomized blocks in a greenhouse.

One week after treatment, a rooted cutting of clone TRI 2024 was planted in each bag and five weeks later, the number of nematodes in the entire root system of each plant counted. Results are given in Table 3.

TABLE 3—*Effect af treating infested soil with marigold root extracts and with α - terthienyl*

	Marigold Extract (Young)	Marigold Extract (Old)	α-terthienyl	Petroleum Ether	Water
Mean number of nematodes (per g. root)	104	163	77	251	222
Transformed Data	9.958	12.596	8.463	15.229	14.302

Least Significant Difference (P = 0.05) = 3.418.

α-terthienyl, and young marigold root extract both significantly reduced the number of nematodes. There was no significant difference in the effect of α- terthienyl and young marigold root extract, indicating that the purified chemical is no more effective than a crude extract, under the conditions of the test and at the concentrations used.

1.7. *Eradication of Nematodes from Infected Tea.*—Further tests with nematocides were carried out in an attempt to eradicate nematodes from infected nursery plants. The method of treatment was the same as that used previously, (Hutchinson, 1963). The chemicals tested were VC 13, Diazinon, Disyston and Bayer 5121, the first two being applied as soil drenches at 1 in 1,000 dilution and the last two in granular form — 5 g. per plant followed by 1 litre of water. There were 4 applications at fortnightly intervals and plants were examined 9 weeks after the final application. Results are given in Table 4.

TABLE 4.—*Effect of treating infected plants with 4 nematocides*

	Disyston	Bayer 5121	VC 13	Diazinon	Control
Nematodes per g. root	35	113	115	296	914

At the concentration used, VC 13 caused severe damage and Diazinon slight damage to the treated plants. Although all treatments considerably reduced the number of nematodes in roots (by more than 96% in the case of Disyston), the degree of control was not satisfactory, because 100% kill is necessary before planting in field soil.

Extensive tests were carried out with Nemaphos, the nematocide which gave the most promising results in 1962. Potted plants, bagged plants and bare-rooted plants were treated with 0.1% and 0.2% solutions of Nemaphos, applied as a soil drench in some tests, while in others the plants were immersed in the namatocide solutions for up to 24 hours. None of the treatments achieved 100% kill and it seems unlikely that nematodes can be eradicated from infected plants by chemical treatment.

1.8. *Differentiation of Populations of P. loosi.*—There is some evidence that nematodes from different localities vary in pathogenicity, (Hutchinson, 1962 and 1963) and two experiments were designed to provide more information on

this. In the first experiment rooted cuttings of clones DK 1, DT95, MO 208 and TRI 2024 were planted in fumigated Guatemala grass soil in polythene bags and 6 months later were inoculated separately with nematodes from Adam's Peak and Chrystler's Farm estates.

In the second experiment clone TRI 2024 was exposed to 5 nematode populations in naturally infested soils and also in inoculated Guatemala grass soil. Half the soil from each treatment was fumigated with D.D. and half untreated. Results of these two experiments are not yet available.

Work is continuing on the differentiation of nematode isolates by means of vulvar ratios and sex ratios.

1.9. *Effect of Fertilizer Mixtures on Tolerance of Tea to P. loosi.*—It has been reported that increased applications of potassium and phosphorus result in improved growth of plants infected with endoparasitic nematodes. A pot experiment was designed to determine if increased levels of these two elements resulted in an increase in the growth of tea infected with *P. loosi.* All pots received 8 g. of T. 200 (770 lb per acre); one third of the pots received an additional 1 g. of muriate of potash (96 lb per acre) and one third, 2 g. additional saphosphosphate. (192 lb per acre). Fertilizer was applied every month and after 12 months, growth of tops and roots and number of nematodes in the roots were measured. There was no significant difference between treatments.

Leaves were analysed for K_2O and P_2O_5 by the Agricultural Chemistry Division, but again there was no significant difference between treatments.

1.10. *P. loosi on Low Country Estates.*—All relevant evidence indicates that damage caused by *P. loosi* is confined to estates above 3,000 feet. Nevertheless *P. loosi* has been detected on some low country estates, although no apparent damage is caused. A simple experiment was carried out to determine if nematodes from the low country can multiply under both low country and up country conditions. No valid conclusions could be drawn.

1.11. *Origin of P. loosi.*—As tea has been grown in Ceylon for little more than 100 years, it seems likely that *P. loosi* lived on other plants before tea was introduced. Jungle soils have been sampled quite extensively and *Pratylenchus* spp. found, but in pot tests none of the jungle nematodes has colonised tea. Another approach was to grow jungle plants in soil heavily infested with *P. loosi.* The plants tested were *Osbeckia walkeri, Impatiens (leptopoda?), Eugenia* sp., *Lobelia* sp., *Myristica* sp. and three unidentified plants one belonging to the family Myrtaceae. None was colonised to any extent by *P. loosi.*

2. Meloidogyne Arenaria

2.1. *Relative Susceptibility of Seedling and Clonal Tea.*—Very young tea is susceptible to *M. arenaria*, but appears to develop immunity with age. However this nematode can cause serious damage to nursery plants and in 1962 and 1963 the suceptibility of seedling and clonal tea was compared. Clones used in the experiment were DT 95, DK 8, GMT 9, K 150, MO 16, MO 146, MO 208, TRI 2024, TRI 2118 and TRI 2135.

Details of the experiment and results of the first assessment, made after 8 months were given by Hutchinson (1963). Final results of the experiment are summarised in Table 5.

TABLE 5.—*Susceptibility of seedling and clonal tea to M. arenaria*

	Wt. of root (g)		Galls per g. root		Females with eggs per g. root	
	After 8 Months	After 15 Months	After 8 Months	After 15 Months	After 8 Months	After 15 Months
Seedling Tea	8.5	121.9	20.6	9.1	17.5	8.3
Clonal Tea	19.6	347.1	7.5	0.9	2.7	0.9

Certain conclusions can be drawn from this experiment: (1) root growth of clones was more than double that of seedling tea; (2) seedling tea is much more suceptible to *M. arenaria* than is clonal tea and (3) there is a marked increase in the resistance of both seedlings and clones between 8 and 15 months.

Although the design of the experiment does not permit a strict comparison between clones, clone TRI 2135 appears to be the most suceptible of those tested. After 15 months, it was observed that although there were few galls, and no females with eggs, on clone TRI 2024, roots were severely damaged (Fig. 3), perhaps indicating a hypersensitive reaction to infection.

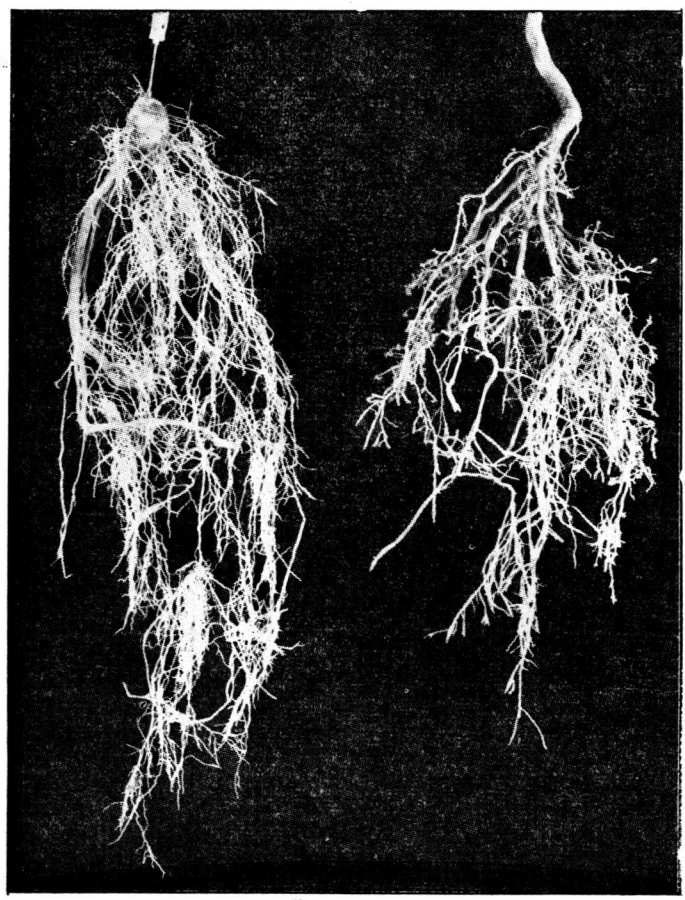

Figure 3 —Roots of clone TRI 2024 grown in soil infested with *Meloidogyne arenaria* (right) and in uninfested soil left.

3. Meloidogyne Brevicauda

3.1. *Host Range of M. brevicauda.*—Tea is the only recorded host for this nematode which is confined to three up country estates in Ceylon. Several plants are being tested for susceptibility to this nematode and present evidence indicates that peanuts are susceptible.

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REPORT OF THE BIOCHEMIST FOR 1963

G. W. Sanderson, Ph.D.

Staff

The Biochemist took up duties at the Institute in February. Mr G. R. Roberts, B.Sc. (Cey.), joined the Division in January as a research assistant.

New Laboratories

One of the new Biochemist's first jobs was to set up new laboratories in the recently completed Administration-Biochemistry Building. The fittings were designed, built and installed in time for the Division to occupy its new quarters in June. The new quarters consist of a large general laboratory, a chromatography room, two offices and a storeroom. This move has alleviated the Division's overcrowded condition very considerably.

The furnishing of the new laboratory with the modern scientific apparatus required for an up to date inquiry into the biochemistry of tea has taken a large portion of the Biochemist's time. In this connection 143 letters have been written, 100 replies have been processed and 62 overseas indents have been initiated. Roughly one-third of this new equipment has already arrived at the Institute and is now in use. It is estimated that by June, 1964, the Biochemistry laboratories will be fully equipped for the undertaking of the work now envisioned.

Visit to North-east India

The Biochemist was fortunate enough to have the privilege of accompanying the Director on a two-week trip to North-east India to attend the 20th Annual Tocklai Conference in November. During this time a tour of some Assam tea gardens and factories was made under the generous auspices of the Tocklai Experimental Station staff. The trip was most helpful in broadening the new Biochemist's knowledge of tea.

A report of this visit has been published in the Tea Quarterly (Sanderson, 1963c).

Experimental

1. The Biochemical Basis of Quality in Tea

Survey of the literature revealed a paucity of sound experimental evidence on this subject with several conflicting interpretations by various investigators (cf. Ramaswamy, 1963). Therefore, as a start, it was deemed necessary to make a detailed preliminary investigation designed to point out which of several chemical quantities formerly implicated in determining quality in tea deserved further investigation.

To do this two clones which differed markedly in quality potential* were chosen for a detailed chemical comparison. Clone TRI 777 which is classified as an "A_1" grade clone,with a high quality potential, and clone TRI 740 which is classified as a "C" grade clone with a low quality potential (Keegel, 1959, 1962) were used. Chemical quantities found to differ between two such clones should have a high probability of being involved in determining quality whereas chemical quantities found to be alike should have a low probability of being involved.

* Quality potential is defined as the potential of a plant, or clone, to make a high quality tea. The potential of a particular plant will vary from day to day but it will remain approximately the same in relation to other plants. Therefore, the quality potential of a plant is an inherent characteristic of that plant.

Experimental teas were made from these clones at each pluck by the Technology Division. The taster's evaluations of these teas are summarized in Table 1 and they show that clone TRI 777 did make a better tea than clone TRI 740.

TABLE 1.—*Average of marks given by four Colombo Tasters to Twenty Teas made from Clones TRI. 740 and TRI.777 over the period 27 March to 14 October, 1963.*

Characteristic	Clone	Average Marks
Infusion	777	6.32**
	740	5.03
Colour	777	8.34**
	740	5.98
Strength	777	6.61**
	740	5.43
Quality	777	5.52**
	740	4.89
Valuation	777	Rs. 2.35**
	740	Rs. 2.16

**Significantly greater at 1% level ($P < 0.01$)

The results of the chemical analyses are summarized in Table 2. These results show that of the fourteen chemical quantities determined seven were present at higher levels in the good quality clone, (suggesting their positive correlation with quality), two were present at lower levels in the good quality clone (suggesting their negative correlation with quality) and five were present at the same level in the two clones (suggesting no correlation with quality).

The above findings have been tested in a limited way already (eleven clones have been sampled simultaneously on three dates and analyzed for five chemical quantities) but more work is required before definite conclusions can be drawn.

The results of this investigation to the end of 1963 will be described and discussed in full in the Biochemist's 13th Biennial Conference Report which will be published in the Tea Quarterly (Sanderson, 1964).

2. The Seasonal Variation in the Chemical Composition of Tea Flush

The investigation into the biochemical basis of quality described above afforded an opportunity to study seasonal variation in the level of the fourteen chemical quantities being measured. Marked seasonal fluctuations were found to occur in all quantities measured. This is shown in Table 2 by the figures in brackets which are the minimum and maximum levels measured over the eight month experimental period. In every case the ranges of the levels of the chemical quantities overlapped in the two clones. Yet the clones had markedly and consistently different levels of nine of the chemical quantities measured on any particular date. This is indicated by the statistical significance of the differences found in these nine quantities. These findings agree with the much earlier ones of Evans (1929) who worked in this same laboratory.

TABLE 2.—*Average Level of Twelve Chemical Quantities in Fresh Tea Flush from Clones TRI. 740 and TRI. 777 over an Eight Month Period. (25 plucks were carried out between 27 March and 2 December, 1963).*

Chemical Quantity Measured	No. of Pluckings Sampled	CLONE		Level of Significance of Differences
		TRI.740	TRI. 777	
		% fresh weight		
Moisture	25	78.0 (76.2–80.2)*	78.2 (76.5–80.2)	None
		% dry weight		
Ash	25	5.35 (4.90–5.77)	4.81 (4.32–5.17)	1%
Total Nitrogen	25	4.69 (4.27–5.65)	4.93 (4.44–5.48)	1%
Caffeine	25	3.13 (2.83–3.95)	3.63 (3.23–4.00)	1%
Protein	25	23.7 (21.3–28.5)	24.3 (21.3–27.3)	1%
Pectin	25	5.42 (3.63–6.42)	5.22 (3.23–6.42)	None
Total soluble solids	25	42.2 (32.5–47.1)	43.3 (31.2–46.9)	1%
Total soluble nitrogen	25	1.71 (1.45–2.27)	2.05 (1.71–2.44)	1%
Total oxidizable matter	25	26.2 (17.0–30.8)	26.5 (14.9–30.7)	None
Crude fats	10	1.38 (1.16–2.03)	1.26 (1.08–1.73)	2%
Crude fibre	12	10.5 (9.9–11.6)	10.3 (9.6–11.6)	None
Total flavanols	25	25.6 (18.2–34.5)	27.0 (20.0–32.5)	1%
		Enzyme units/g acetone powder		
Polyphenol oxidase	24	71.4 (31.3–171.1)	164.3 (89.9–376.0)	1%
Pectin esterase	16	6.54 (1.65–20.45)	6.00 (1.25–16.29)	None

*Brackets enclose minimum and maximum values found.

Realization that the starting material used in manufacturing tea, *i.e.* the fresh flush, varies markedly in composition day by day suggests that it may be necessary to tailor-make manufacturing programmes on a day to day basis in order to realize the potential of every days pluck. Before this can be done, however, we must determine what effect these fluctuations have on the quality of the final product, we must determine what changes in a particular manufacturing programme are required to realize the potential of a given pluck and last, but perhaps most important of all, we must develop means whereby a tea maker can evaluate his day's pluck in time for this information to be of use to him. All of these problems require additional research to find solutions.

These results also point up the necessity of sampling clones simultaneously when making comparative studies. Failure to appreciate this fact has undoubtedly led to many of the conflicting conclusions which are found in the literature.

Attempts to correlate these fluctuations with weather data available for the Tea Research Institute have not been successful, even though it is very likely that climatic factors do determine these fluctuations. Equipment should soon be available to enable a more controlled investigation to be carried out during the year 1964.

3. Nitrogen Metabolism in Tea

Roberts and Wood (1951) reported an increase of free amino acids on withering of tea flush. Bhatia (1961, 1962a, 1962b) has recently confirmed this report and he has used this increase in free amino acids during withering as a measure of the degree of chemical wither to compare natural and artificial methods of withering.

A detailed investigation of this subject has been initiated in this laboratory or the purpose of determining the importance, if any, of these changes as regards tea making.

It has been found that flush steamed prior to withering does not exhibit an increase of free amino acids on subsequent withering which suggests that the increase is due to the activity of an endogenous enzyme which hydrolyses tea leaf proteins. Investigation has shown that partially purified acetone powders, prepared according to a modification of the method of Sreerangachar (1943), do in fact contain a proteolytic enzyme. The enzyme involved, properly called peptidase, was studied by measuring the increase in amino acids on incubation in a buffered solution containing the protein casein. This enzyme system was found to have maximum activity at pH 5.2 and at a temperature of 52°C.

A report of the findings to date is being prepared for publication in a scientific journal. The practical importance of this enzyme and its role in tea manufacture are the subjects of continuing research.

4. Organic Acid Metabolism in Tea

An investigation was undertaken to ascertain the various organic acids present in fresh tea flush and the changes which they undergo during the various stages of manufacture.

The first stage in this investigation was standardization of the chromatographic procedure for separating pure authentic organic acids on silica gel columns (Isherwood, 1946, Bulen, *el. at.*, 1952, and Wager and Isherwood, 1961). The next stage was the development of a method for extraction of the acids from fresh plant material. In the procedure adopted, an 80% aqueous

ethanol extract is concentrated and purified by passing through ion exchange columns. Organic acids are then determined by stepwise elution from a silica gel column using graded mixtures of pentanol and chloroform.

The following acids were found to be present in appreciable quantities in fresh flush: oxalic acid, malic acid and citric acid. In addition to these three acids, three other unidentified acids were found to be present at much lower levels.

A report on the findings to date which is to be published in a scientific journal is in preparation. Further work to determine the fate of these organic acids during tea manufacture and their importance in this process are in progress.

5. The Chloroform Test, A Rapid Means of Evaluating Fermenting Properties of Clones

The Chloroform Test is an old test (cf. Carpenter and Harler, 1926) for testing fermenting properties of tea bushes. Interest in the test has recently been revived by Bendall (1959) and it is now used widely in East Africa (Chenery, 1963).

Before recommending this test for use, an investigation of its reliability was carried out. This investigation showed that the Chloroform Test does give a reliable indication of the fermenting properties of tea plants (clones). Furthermore, it is a rapid test which is very easy to carry out. The test is recommended for use in the initial stages of clonal selection work.

The test and its limitations are fully described in the Tea Quarterly (Sanderson, 1963d).

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REPORT OF THE TECHNOLOGIST FOR 1963

E. L. Keegel

1. Staff

There was no change in the staff. The post of an additional Research Assistant, who would primarily be concerned with factory development work, has not yet been filled.

2. Advisory

As in previous years advisory work was heavy — 70 visits were made to factories and nearly 750 samples examined. 791 letters were received and 705 despatched.

3. General

The course in tea-manufacture given to tea-makers in 1962 was extended to Superintendents and Assistant Superintendents, and was confined to 5 main centres. Details are as follows:—

Date	*District*	*Venue*	*Attendance*
25-2-63	Badulla	Uva Club	103
4-3-63	Dickoya	Darawella Club	32
11-3-63	Dimbulla	Talawakele Club	72
18-3-63	Nuwara Eliya	N'Eliya Golf Club	29
22-3-63	Kandy	Kandy Club	81
		Total ...	317

The papers and discussions are presented in Monograph No. 5.

4. Clonal

4.1. *Tests for Estates.*—Despite the offer made by the Institute to Estates to carry out manufacturing tests of their clones (Keegel 1962), the response was very poor. Only 5 estates took advantage of the facilities available at the Institute.

4.2. *Assessment of quality by chemical methods.*—In the annual report of the Biochemist for 1961 (Ramaswamy 1962), 14 of the 81 clones mentioned appeared to be of doubtful classification. Repeated manufacture tests of the clones in question necessitated the re-classification of some of them. The results are given in Table 1. Owing to unavailability of suitable and sufficient material, two clones that were listed in the A1 group (Keegel 1959), namely W14 and DK 19 remain to be examined. Pending further tests, the classification of these two clones, in the light of Ramaswamy's observations, must therefore for the time being be regarded as doubtful.

TABLE 1.—*Assessment of quality by chemical methods and by tasting opinion*

Clone No.	Rank (1959)	Possible grouping according to chemical analysis	Re-classification according to tasting opinion
W-14	A1	B or C	To be re-tested
DK-19	A1	B or C	
TRI-16	A 2	B or C	A 2 — No change
TRI-23	A 2	B or C	A 2
TRI-45	A 2	B or C	A 2
TRI-1016	A 2	B or C	A 2
TRI-170	B	A 1 or A 2	A 2 — All up-graded
KEN-15/8	B	A 1 or A 2	A 2
KEN-15/13	B	A 1 or A 2	A 2
KEN-16/3*	B	A 1 or A 2	A 2
OK-3	B	A 1 or A 2	A 2
TRI-407	C	A 1 or A 2	A 1/2 — All up-graded
TRI-2065	C	A 1 or A 2	B
TRI-2115	C	A 1 or A 2	A 2

*re-classified B in 1961.

The assessment of quality by chemical methods received further attention by the Biochemical Division during the year, and for this purpose 2 clones were chosen—TRI 777 in the A 1 group of classification (Keegel 1959) and the other TRI 740 in the C group. The examination commenced from the 2nd tipping and continued for every pluck.

The results are discussed in the report of the Biochemist, but attention should be drawn to the small difference in quality so far noted, as indicated by the average marks given by 4 tasters. One reason for this is that whereas 2 tasters consistently preferred TRI 777, the other two were inclined to give preference to TRI 740. However, the fact should not be lost sight of that the material under test was very young leaf, which cannot be expected to produce good quality tea however outstanding the clone may be. Nevertheless, the difference in quality between TRI 777 and 740 was statistically significant.

These results once again emphasise the necessity for the greatest care to be taken in the selection of material for the assessment of potential quality. Leaf taken for manufacture should come from bushes which have been in *regular* plucking for at least 6 *months*.

Table 2 gives the average marks and valuations received by the two clones up to the 20th manufacture, when the bushes were just over 6 months from the 1st plucking.

TABLE 2.—*Average marks and valuations obtained by clones TRI 777 and TRI 740 for the first 20 manufactures from the 2nd tipping.*

Clone	Infused leaf	Colour	Strength	Quality	Valuation
TRI 777	6.7	8.2	6.6	5.7	Rs. 2.35
TRI 740	4.9	5.9	5.9	5.0	Rs. 2.17

5. Withering Materials

Since April 1962, various types of nylon and plastic mesh have been on trial, and are being observed for their wearing properties and suitability for withering tats.

The following materials are under test:—

Date of installation	Manufacturers	Agents	Type of material	No. of meshes per sq. inch.	Estimated cost per sq. ft. of tat area
1. April 1962	—	I.C.I.	Terrylene (small mesh)	49	27 cts.
2. April 1962	Courtald & Co. (U.K.)	—	Polythene Courlene × 3	20 (4×5)	25 cts.(c.i.f.)
3. April 1962	Fukui Fishing Net Co. (Japan)	Bristol Agency	Mycle net	16	21½ cts.
4. April 1962	—	I.C.I.	Terrylene (large mesh)	30 (5×6)	27 cts.
5. April 1962	Reeves (U.S.A.)	—	Polythylene yarn (heat stabilized)	12 (4×3)	25 cts. (c.i.f.)
6. April 1962	Nippon Seimo Co. (Japan)	P.P.P. Jinadasa	Kuralon net	25	22 cts.
7. Sept., 1962	Chicopee Mills (U.S.A.)	—	Lumite woven polypropylene fabric	16	15 cts. (c.i.f.)
8. March 1963	—	D. V. Martenstyn & Co.	Tetoron (Terylene)	16	19½ cts.
9. April 1963	—	D. V. Martenstyn & Co.	Crocodile brand nylon	16	19½ cts.
10. June 1963	—	I.C.I.	Ulstron 3014	9 (3×3)	21 cts. (f.o.b.)
11. Sept. 1963	R.F.D. Ltd. (U.K.)	Shaw Wallace & Hedges Ltd.	Ultranet	28 (4×7)	24 cts.

It is too early yet to assess the relative merits of some of these materials. Of the monofilament types, however, No. 7 which was installed later than the other two, is already showing signs of wearand tear; the filaments are loose and tending to break. The Reeves product seems to be better than the Courtald's,

and its condition compares favourably with the nylon materials installed at the same time. The two I.C.I. Terylene materials do not seem to be as good as Mycle and Kuralon net.

6. Nylon Mesh for Fermenting

During the last year or so, a number of estates have been using nylon mesh for fermenting with apparent success. Some estates contended that the use of nylon mesh for such a purpose improved colour, whilst others asserted that quality was enhanced. The results brought to our notice were so conflicting that it was felt some investigation ought to be made.

A few preliminary experiments were carried out, comparing nylon mesh with aluminium under identical conditions. The conclusions arrived at were in agreement with the results of past experiments, where it was shown that tea appears to ferment equally well on any type of fermenting surface, so long as the latter is kept clean.

7. Rotorvane Manufacture

The Rotorvane machine was developed at the Tocklai Research Institute, and is available in two sizes—8″ and 15″ diameter. According to the claims made for the machine, liquoring properties are improved and factory procedure is simplified.

At the time the 8″ machine was installed at St Coombs there was little knowledge of R.V. manufacture, and the only information available was that the practice in South India was to give the leaf two rolls in an ordinary roller and to extract 40 to 50% dhool. The balance is then passed through the R.V. 2 or 3 times. The big bulk outturn was in the region of 5%.

Most of the initial work carried out at St Coombs was done on these lines, but as time went on and more experience gained about the machine, variations in the method of processing were undertaken. The conclusions given at the end of this report were drawn from the results of over 100 separate experiments.

7.1. *Factors Investigated*

(i) *Degree of wither.*—No definite conclusions were reached. A softer wither tended however to make the tea blacker with no improvement in style. There was no indication that liquors were substantially improved, and the main noticeable effect was on temperature, as shown in the figures given in Table 3.

TABLE 3.—*Effect of wither on temperature of rotorvaned leaf.*

	Rise in temperature—°F	
	Hard wither	Soft wither
Unrolled leaf (1st pass)	16	13
,, ,, (2nd pass)	17	14
Rolled ,, (1st pass)	10	5
,, ,, (2nd pass)	16	12

On the whole, a softer wither results in a lower temperature of about 5°F. It is of interest to note that the rise in temperature of rolled leaf is much less than that of unrolled leaf in the 1st pass only, and that a considerable rise

occurs in the 2nd pass when compared with that during the 1st pass. In the case of unrolled leaf, however, the rise in temperature is about the same in both passes.

Dhool outturns did not seem to be affected by the degree of wither, unless the wither was particularly soft so as to cause clogging of the roll-breaker mesh.

(ii) *Rate of feed.*—The higher the intake, the lower the dhool outturn initially, with a corresponding improvement in appearance in the main grades. The liquors are almost identical. Though an apparent advantage is likely to be gained from increasing the rate of feed to the machine, too high an intake increases off-grade outturns considerably, as shown in Table 4.

TABLE 4.—*Effect of increasing the rate of feed on grade outturns.*

	Rate of feed—lb per hour			
	1330	1850	2000	2560
% B.O.P.	63	52	46	44
% B.O.P.F.	18	16	17	12
% Dust	13	11	12	12
% F.2.	2	14	17	23
% B.M.	4	7	8	9

(iii) *Number of passes.*—Three successive passes were not as effective as two passes with intermediate roll-breaking in reducing the big-bulk outturn. Although the two methods of treating the leaf made no appreciable difference to grade outturns, two passes with intermediate sifting out of the fines gave a tea with better appearance and also tended to improve quality.

It would also appear that there is no advantage in passing leaf too many times in a Rotorvane, merely for the sake of reducing the big bulk to a very low level. The number of passes depends on the extent to which the leaf is pre-conditioned before it is rotorvaned. Thus leaf that has had only a few minutes pre-rolling in an ordinary roller would require at least 3 passes, whereas leaf from a 3rd roll bulk would not need more than one pass to get a normal outturn of big-bulk. Table 5 gives some typical dhool outturns obtained.

TABLE 5.—*Effect of pre-conditioning of leaf on number of passes in Rotorvane.*

	PERCENTAGE DHOOL OUTTURNS			
	10 minutes pre rolling	1st roll bulk	2nd roll bulk	3rd roll bulk
	(no dhool taken out prior to rotorvaning)	(15% dhool taken out)	(15+20 =35% dhool)	(15+20+25 =60% dhool)
R.V. 1. — 53		40(47)	35(54)	27(71)
R.V. 2. — 28		26(30)	20(31)	—
R.V. 3. — 12		14(17)	—	—
Big bulk — 7		5(6)	10(15)	13(29)

NOTE:—Figures within brackets correspond to the percentage outturns of dhool expressed on the initial weight of leaf charged to the Rotorvane.

It should be noted that the figures given in Table 5 would vary considerably, depending on the speed of the Rotorvane, the manner and rate of feeding, the wither, and also on the method of roll-breaking. But it is quite evident that the more rolling leaf initially receives, the less number of passes required in the Rotorvane. Excessive rotorvaning spoils appearance. Just as in normal rolling, the decision whether to have an additional pass or not should rest on the outturn of big bulk obtained. If the latter is too high, liquors suffer.

(iv) *Pre-conditioning of the leaf.*—Withered leaf fed direct into the Rotorvane without any pre-rolling gives a satisfactory tea, but rather poor in appearance. Compared with orthodox manufacture, B.O.P. outturn is lower and a greater quantity of dust and B.M. is produced (see Table 6). For these reasons alone, pre-rolling of the leaf is most desirable. It is also difficult to feed un-rolled leaf into the Rotorvane.

TABLE 6.—*Percentage grade outturns of withered leaf rotorvaned compared with orthodox manufacture.*

	Rotorvane (leaf not pre-rolled)	Orthodox
B.O.P.	43	56
B.O.P.F.	30	27
Pekoe	7	7
Dust and B.M.	20	10

On pre-rolling the leaf, whether for a few minutes or for longer periods a less amount of secondary grades is produced, and the grade outturns obtained are almost identical with those from normal manufacture. Contray to expectation, the Rotorvane did not produce a significantly higher outturn of B.O.P. and B.O.P.F. than orthodox, one probable reason being that hard rolling is adopted at St Coombs.

As regards the effect of the degree of pre-conditioning of the leaf on liquors, it was not possible to reach any definite conclusion. Neither was it possible to reach any conclusion on the effect of normal rolling of leaf that had been rotorvaned. It was also not possible to establish anything from treating the dhools only in the Rotorvane.

In a few isolated instances, the Rotorvane has produced a more valuable tea than orthodox, the reasons for which are not clear.

(v) *Effect of speed:*—The main effect of speed is on the through-put of the Rotorvane. Comparative average figures for the first pass at 3 different speeds are somewhat as follows:—

15 r.p.m. — 600 lb per hour.
25 ,, —1,000 ,, ,, ,,
35 ,, —1,300 ,, ,, ,,

The intake could of course be varied considerably, depending on how the machine is fed. For example, with continuous feeding by means of a moving belt arrangement, the above figures could be almost doubled.

Intake also increases in subsequent passes, as indicated by the figures given in Table 7.

TABLE 7.—*Effect of speed on intake.*

	Pounds per hour		
	1st pass	2nd pass	3rd pass
(*a*) *10 mins. pre-rolling*			
15 r.p.m.—	800	1000	1000
35 ,, —	1600	2400	2600
(*b*) *1st roll bulk*			
15 r.p.m.—	700	1000	1100
35 ,, —	1200	1500	1600
(*c*) *2nd roll bulk*			
15 r.p.m.—	600	900	—
35 ,, —	1000	1500	—

On the results of the three different speeds investigated, there is little to choose between one speed and the other. There are indications that increasing the speed improves the appearance of the tea. In any case, since liquoring properties are not impaired by a higher speed, there is no point in using the machine at low speeds because of the smaller throughput.

It has been suggested by the manufacturers of the Rotorvane that in certain conditions (not stated) the machine could be operated with success even at a speed of 50 r.p.m., and it would seem from the information available from India that the Rotor speed has been found to be critical. The matter is under investigation.

7.2. *Appearance*

The R.V. quite definitely produces a browner and flakier tea than an orthodox roller, and with more stalk—a result to be expected since the machine acts rather like an epicyclic pressure roller. The teas produced from this machine are aptly described as "a cross between C.T.C. and orthodox".

On the Colombo market a straight R.V. manufactured tea would, because of its poor appearance, suffer a price set-back, when compared with orthodox, although its liquor value may be higher. This difference appears to be most marked in leaf taken from the later rolls. It follows therefore that if a Rotorvane tea is to command a higher price than a tea manufactured on orthodox lines, its liquoring properties should be significantly superior. On the London market, however, this condition may not apply provided the tea is free from fibre and stalk and properly graded.

7.3. *Liquor*

The experiments carried out so far have not given startling results, and treatment of leaf in the R.V. has in some cases not brought about a noticeable improvement in colour and strength, but quality was maintained in both the main grades. The effect on flavour was not investigated.

Of the various techniques tried out, the method that has given the most promising results is one in which the leaf is first given a 30 minute roll under pressure in order to get a twist before it is rotorvaned. Roll breaking and separation of the orthodox dhool is not necessary. The whole of the leaf discharged from the roller is treated directly in the Rotorvane.

Tentative conclusions.—Under the conditions examined so far, we have not been able to produce a more valuable Rotorvane tea than orthodox manufacture except in a few isolated instances, the reasons for which cannot be clearly established. Perhaps the hard rolling adopted at St Coombs has been the contributory factor or the results may have been due to the fact that we have not yet determined the optimum conditions under which the machine should function.

The small effects on colour and strength are rather disappointing, and were not nearly so pronounced as might have been expected. Commercially, there was no noticeable difference in the liquors between Rotorvane and orthodox in the majority of the experiments that were carried out. The results were hardly encouraging in view of the claims made in N.E. India. Nevertheless there is some encouragement to those estates contemplating R.V. manufacture, to know that a modification in the vanes has brought about a noticeable improvement in the teas from this type of manufacture in S. India. The modified machine is shortly to be tried out at St Coombs.

That a satisfactory liquoring tea can be obtained from Rotorvane manufacture is beyond question, but the problem has been to obtain a tea of reasonably good appearance to have no adverse effect on the valuation. The only shortcoming in a Rotorvane tea is its appearance, and this has, more often than not, reduced prices. There are indications that appearance can be improved by increasing the speed of the machine, but more important a factor seems to be the uniformity of pressure within the cylinder, which is governed by the method of feeding. The inconsistent results could very well have been due to this factor.

In the absence of sufficient evidence on the factors responsible for the inconsistent results we have had from the Rotorvane, we are not yet in a position to make any firm recommendation on how best the machine could be used as a substitute for an ordinary roller. The traditional orthodox appearance of even high grown teas is still extremely important for certain markets, and for this reason the type of leaf and standard of plucking has to be seriously considered before a Rotorvane is installed on any particular estate, however strong the desire may be to try out this new method of manufacture.

8. The C.T.C. Process

The increasing popularity of the C.T.C. process in Assam calls for viewing the matter again in the light of its application to Ceylon. It is well known that in the case of Assam the adoption of this method of manufacture has resulted in a marked improvement of liquors and certain gardens have found it very profitable. The poorer appearance of the teas has curiously not been an adverse factor in their sales value in the London market. It was feared that with an increased production of this type of teas, saturation point, as far as the blender is concerned, would have been reached, but this does not seem to be the case and the present trend appears to be towards a wider adoption of C.T.C. manufacture. Nearly half or even more of North India's tea crop is believed to be manufactured by the C.T.C. process, and according to the latest information, some estates in South India have in fact already gone in for this method of manufacture.

The first question that naturally comes to mind is whether there would be an excess of C.T.C. teas should Ceylon also decide to follow the example of India. It would appear from all accounts that though there is an ample supply of this type of tea available, there is, if anything, too much C.T.C. teas on offer without any real character. This also applies of course to orthodox teas. The more C.T.C. teas produced therefore, the more discriminating the demand. It is thus evident that one cannot expect to improve one's

prices, whatever success has been achieved in North India, merely by a conversion of orthodox manufacture to the C.T.C. process. The product has to be of a reasonably high standard to command a premium.

The second question is whether Ceylon would profit by this system of manufacture. Would it be a dangerous thing to alter the nature of the grades entirely in the case of a tea that has established a mark? It probably would be dangerous but there are quite a number of estates particularly in the mid-country turning out mediocre teas, which might benefit from C.T.C. manufacture.

The next question is: for how long is the importance of appearance in Ceylon teas going to last? Barring Middle East requirements and special markets, the overseas buyer appears to be mainly interested in teas with colour and body of a liquor. So long as the average consumer places 'cup quality' above 'appearance', there is some hope of the C.T.C. system proving a profitable investment to the mid-country producer.

When the C.T.C. machine was first tried out in Ceylon over 30 years ago, the results were not at all encouraging. The teas were considered unsaleable because of the drastic alteration in their style. In an attempt to get the colour and strength associated with an Assam tea, the leaf was unduly broken up. The objective was not realized in any case because to the best of our knowledge the experiments were confined to leaf not entirely suitable for the C.T.C. process.

It should be remembered that under Assam conditions, light withers and light rolling have been the general rule even before the introduction of the C.T.C. machine. Despite the light rolling, however, the leaf possesses inherent colour and strength, and these properties are accentuated by the use of the C.T.C. machine. The asset essential to coloury strong liquors is inherent in the succulent leaf that Assam grows. The necessity to over-process the leaf does not therefore arise and the appearance does not suffer much in consequence. The success of the C.T.C. machine in Assam, as far as the requirements of the London market are concerned, is thus easily explained.

However, the present relaxation on the part of some foreign buyers towards the appearance of tea is encouraging enough to explore further the possibilities of a process such as the C.T.C. There is no doubt that the process increases colour and strength but this improvement alone if applied to a Ceylon tea is not the only factor to consider. The orthodox type of manufacture that Ceylon has continued with, despite revolutionary methods elsewhere, has created a distinctive character in its teas, sought after by buyers all over the world. The important question, therefore, that needs to be investigated is how the C.T.C. process, because of its drastic action on the leaf, affects this character.

The general procedure in North India is for the leaf to have a fairly light wither and to receive a conditioning roll in an orthodox roller before it is passed through the C.T.C. machine. The process is very simple after that. The leaf is cut twice or thrice depending on the gap between the rollers and the nature of the leaf. In the experiments carried out at St Coombs we did not deviate much from the normal practice in North India, but we investigated various factors with a view to determining the most suitable working conditions in the light of previous results obtained from the C.T.C. process. One main change made was that instead of the double firing process common in North India, we fired the teas in one operation. The following results were obtained with a 24" mini-machine, kindly loaned by the Brittannia Engineering Co. Ltd., of Calcutta, India.

8.1. *Working Conditions*

(i) *Type of Leaf.*—There is no doubt about it that the standard of plucking must be high for the C.T.C. process to be a success, because of the severe treatment the leaf receives. If it is not good, the product is brown and fibrous and is of no value to the trade however useful the liquors may be.

Very old leaf consisting of tough banji likewise gives a brownish tea and examination of leaf of different ages from pruning revealed that the younger the leaf the blacker the tea, the difference being much more marked than in orthodox manufacture.

One feature of the C.T.C. process according to the preliminary investigations carried out is that older leaf can be made to produce just as much as colour and strength as obtained from younger leaf, other conditions being equal.

(ii) *Degree of wither.*—Hard-withered leaf is not suitable material because it tends to jam in the C.T.C. machine. In any case the object of C.T.C. manufacture is defeated if soft withers are not taken, since liquoring properties and appearance suffer. It would appear that much softer withers than those adopted for conventional manufacture are required to get the best results but no conclusive evidence was obtained with respect to the optimum degree of wither. Different types of leaf may require different withers, and the matter is under investigation.

(iii) *Pre-rolling.*—This does not result in any fundamental change in liguoring properties, but does improve the appearance slightly, thus increasing the value of the tea. A rolling period of 15-30 minutes is sufficient to give the required amount of twist. Longer periods are to be examined.

(iv) *Method of cutting.*—This is very critical, the appearance and liquoring properties being very appreciably affected by the number of cuts and the gap between rollers. Too fine a cut results in a brownish tea, and excessive cutting also brings about a similar effect. With a less severe treatment liquors are inferior and experiments are now in hand to determine the best conditions for obtaining a standard of appearance suited to market requirements without jeopardising the liquoring properties associated with C.T.C. manufacture.

(v) *Roll-breaking.*—Separation of the fines from the first cut with a view to avoiding unnecessary cutting of fine particles, resulted in the leaf acquiring a 'grape-nut' type of appearance, which is disliked by blenders.

(vi) *Fermentation.*—As in the case of normal rolling, extended periods lead to an improvement of colour with loss in quality. Increasing the temperature of fermentation very definitely results in softness and a decline in quality, with no compensating improvement in the liquor. On the whole a fermentation at room temperature gave the best all-round results. Thickening the spread interferes with the fermentation process.

(vii) *Firing.*—The best results were obtained from a normal firing temperature of 190°F, and a drying period of 21 minutes. Load, of course, has to be slightly less than with normally manufactured leaf because of the extra moisture in the leaf and its smaller size.

8.2. *Grade Outturns*

According to the information available from North India, there would appear to be considerable differences, not only in grade outturns but also in grade sizes. The following figures obtained from various sources are fairly representative of results in Assam:—

B.P. grades	...	10 to 25%
Fgs. ,,	...	45 to 55%
Dust ,,	...	20 to 30%
Secondary grades	...	10 to 15%

Main saleable grades amount to 60-70% of the crop. Residue and waste is supposed to be in the region of only 3%, but we have reason to believe that this low figure applies to only those gardens with a good standard of leaf, and may be as high as 10%.

In the trials carried out at St Coombs we have so far not been able to get the very high outturn of fannings obtained in India, typical figures being:—

B.P. grades	...	30%
Fgs. ,,	...	33%
Dust ,,	...	22%
Secondary grades	...	15%

The main saleable grades represent 63% of the crop.

8.3. *Appearance*

Various types of teas can be produced in the C.T.C. process ranging from a "shotty" appearance to a very flaky type, depending primarily on the type of leaf and treatment it receives. As regards the colour of the made tea, this has generally been brownish and not as black as the better C.T.C. Assams. Except for some samples which were too brownish for the market, resulting from poor leaf and/or excessive cutting, the overall standard of appearance can be considered satisfactory and quite presentable, and compares favourably with the usual standard of C.T.C.'s.

In comparison with orthodox manufucture, however, the poorer appearance of the C.T.C. teas detracts considerably from their market value. The comparison given below (Table 8) indicates how the market values of the teas have been affected by their leaf appearance. It also shows the influence of the type of leaf, which has had a noticeable effect.

TABLE 8.—*Effect of appearance on Valuation*

Field No. and age from pruning	Method of manufacture	Liquor value (ignoring leaf appearance)	Value (including leaf appearance)
No. 12 17 months	Orthodox C.T.C.	4/6d 4/10½d	4/8½d 4/9½d
No. 5 31 months (mostly low jat hybrid)	Orthodox C.T.C.	4/9d 4/11d	4/10½d 4/7d
No. 10 42 months	Orthodox C.T.C.	4/8d 4/10½d	4/9½d 4/8d

8.4. *Liquors*

Though the C.T.C. teas produced at St Coombs do not possess the rich colour and body for which most Assam C.T.C.s are renowned, the process has

certainly enhanced the colour and strength to a degree not attainable in orthodox manufacture. There is no evidence to suggest from the work done so far that high grown quality is impaired but the harshness in the liquors is considered to be out of character with Ceylon teas. A consoling feature, however, is that none of the samples could really be taken for any other than Ceylon tea. On the so-called loss of Ceylon character, tasting opinion both in Colombo and London are somewhat conflicting. St Coombs leaf on the whole for some reason or other does not possess the typical Dimbula character, being somewhat harsh. A process such as the C.T.C. must naturally emphasise this character and it is therefore possible that this inherent character has given rise to some of the remarks made about the loss of Ceylon character. The fact that in some experiments the harshness was eliminated, strongly supports this contention.

With regard to flavour, there appeared to be a suspicion of loss of flavour occurring, which cannot of course be fully established till we get typical dry weather conditions. Nevertheless, it may be of interest to record that teas from clone T.R.I. 2024, manufactured in March this year by the C.T.C. process received the following comments from a leading buyer in the U.K. "We were impressed with these samples as having liquors of immense body and strength and possessing a quite attractive type of flavour similar to that found on the early "second-flush" production from the Dooars in Northern India, and not unlike that "germoline" character which is found on certain Uvas, manufactured during July/August".

It is undisputed that the process improves colour and strength without loss of quality, and in the case of leaf with little inherent quality this characteristic is improved. Table 9 shows the results obtained from leaf grown at St Coombs and at St Joachim (low-country).

TABLE 9.—*Average marks and valuations for two types of leaf.*

	Infusion	*Colour*	*Strength*	*Quality*	*Valuation (Market Value)*
		St Coombs leaf			
COLOMBO TASTERS					
B.O.P. (Orthodox)	5	6	6	7	Rs. 2.47
B.P. (C.T.C.)	7	8	7	7	,, 2.47
P.F. (,,)	7	8	7	7	,, 2.31
F. (,,)	7	9	8	7	,, 2.43
LONDON TASTERS					
B.O.P. (Orthodox)	6	4	6	7	5/0 d
B.P. (C.T.C.)	7	7	8	7	5/4 ,,
P.F. (,,)	7	8	8	7	5/7 ,,
F. (,,)	7	8	9	7	5/6 ,,
		St Joachim leaf			
COLOMBO TASTERS					
B.O.P. (Orthodox)	3	5	5	2	Rs. 1.58
B.P. (C.T.C.)	5	6	5	3	,, 1.56
P.F. (,,)	4	6	6	3	,, 1.57
F. (,,)	5	7	7	3	,, 1.65
LONDON TASTERS					
B.O.P. (Orthodox)	3	5	5	2	3/9 d
B.P. (C.T.C.)	4	5	5	3	3/9 ,,
P.F. (,,)	4	6	6	3	4/0 ,,
F. (,,)	4	6	7	3	3/11 ,,

The outturns of the respective grades compared were as follows:—

B.O.P. (Orthodox)	—	about 60%	
B.P. (C.T.C.)	—	,, 35%	Total 65%
F.P. (,,)	—	,, 13%	
F. (,,)	—	,, 17%	

Tentative conclusions:—It has not been possible yet to form a true idea of the actual value of the experimental samples made at St Coombs or assess the average proceeds of C.T.C. manufacture because of the variable results from different types of leaf. However, given the right material and the right conditions of manufacture, a tea acceptable in appearance to most of the United Kingdom trade can be produced from Ceylon leaf by the C.T.C. process. The make is not satisfactory enough for the Colombo market, and such teas are unlikely to find favour with the local trade, unless used in blends.

It is extremely doubtful, of course, judging from samples of Indian C.T.C. teas we have seen, that our Ceylon C.T.C's will ever be able to compete with the best of the Assam productions. But since there are many Ceylon teas which suffer price set-backs mainly due to lack of colour and strength and never to a great extent on inferior leaf appearance, it might be in the interest of such teas to encourage this form of manufacture.

In teas of this class it would certainly not be advantageous to go for very much extra colour and strength at the expense of appearance since even in the London market a very poor leaf appearance would reduce realization prices considerably however superior the liquoring properties may be. To get the desired objective, therefore, a balance must be struck between leaf appearance and liquor.

Apart from the method of processing which alters the leaf appearance considerably, it was found that the main contributory factor was the leaf, not necessarily the standard of plucking alone but also the type of jat. The process is quite definitely not suited for coarsely plucked leaf and hard China hybrid type leaf or even 'old' leaf. It would appear, therefore, that however useful a liquor the C.T.C. machine may produce its use is limited in Ceylon, particularly in the high grown areas, because of our long pruning cycles and the preponderance of low jat leaf. In the light of the results obtained from clone TRI 2024 grown at St Coombs, the process seems to be worth exploring in those areas, where the leaf is succulent and short pruning cycles are adopted.

It would perhaps not be possible to produce the sort of liquor Assam turns out,but given the right conditions there is every likehood of the value of some Ceylon teas being considerably enhanced by the adoption of the process.

The main requirements are:—

(*a*) Fine leaf.
(*b*) Succulent type of leaf.
(*c*) Leaf comparatively young from pruning.
(*d*) A good twist before processing, which also means a good wither.
(*e*) Sharp roller cutters.
(*f*) Minimum treatment in the C.T.C. machine.

9. Trough Witherer

Experiments on this unit commenced in June. Compared with tat withering, the tea from the trough showed no difference. The comparisons were made for equal periods of withering. It was not possible of course to have the

same temperature conditions, when heated air was used for the trough. However, despite the difference in temperature and number of hours of hot air used, between the trough and tats, the teas from the two systems of withering were practically identical.

Trials of a more technical nature are proceeding to include the investigation of such factors as air flows and optimum temperatures.

10. Publications

Monograph No. 5 — One day course in tea manufacture.

11. Acknowledgements

It is a great pleasure once again to acknowledge the assistance from the tea tasters both in Colombo and London and their readiness to report on the numerous experimental teas. The service they have rendered is greatly appreciated.

References

KEEGEL, E.L. (1959).—Tea made from clones. *Tea Quart.* **30**: 134-141.

RAMASWAMY, M.S. (1962).—Report on Biochemistry for 1961. *Rep. Tea Res. Inst. Ceylon:* 63-70.

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REPORT OF THE STATISTICIAN FOR 1963

P. Kanapathipillai, B.Sc. (Lond.) F.S.S.

Staff

There were no changes in staff during the year and the Division continued to be manned by a Statistician and a Technical Assistant.

In its second year of existence and with its present complement of Staff, the Division concerned itself with only the design, analyses and statistical interpretation of field experiments.

1. Designs

Apart from the usual replicated trials, two designs were drawn up, each being in a single replicate. This was necessitated by limitations of land.

1.1. *Manure-Forking Trial on Field 13, St Coombs.*

A single replicate of a 3^3 design in three blocks of nine plots each—all main effects and two-factor interactions being clear of confounding.

1.2. *Weedkiller-Fertilizer Trial.*

Six fertilizer treatments were arranged in a 6×6 Latin Square in a single replicate. Three additional treatments (levels of Simazine) were superimposed such that each additional treatment occurred twice in each row and twice in each column. This design was adopted as on 6×6 Graeco-Latin Square exists.

2. Analyses

The data from the following major experiments were analysed by the Division.

2.1. The Endane Manurial Experiment 3^3 (NPK) for the last six month period both in relation to yield and shot-hole borer infestation.

2.2. The Palmgarden Manurial Experiment 3^4 (NPKF) for the 1st cycle 1961-63. (F stands for Frequency of Application).

2.3. Several experiments on the rooting of clonal cuttings using "Fermate", bags of different sizes, sulphur and aluminium sulphate and various amounts of phosphate in the nursery.

2.4. 3^3 (NPK) Trial on young clonal tea conducted by the Agronomy Division. The analyses were in respect of the number of leaves, height, tipping weight and diameter measurements both at ground level and at 2″ above ground level.

2.5. Maintenance leaf-fall data—dry weight of leaf-fall, yield, average ratings, leaf and twig weight after pruning; dosage—mortality studies of four fungicidies including Perenox.

2.6. Nematode population data in relation to yield, fertilizers, susceptibility of clones, and treatments such as marigold, Guatemala grass and fallow.

3. Sampling

3.1. *Estimation of eelworm population.*

A portion of field No. 9, ¼ acre in extent was sampled in two ways.

Starting from a randomly located point, soil samples were taken systematically at points 40 ft apart along rows up and down the slope thus traversing the entire area. The rows were 20 ft apart. All the soil samples collected from these points were then bulked and thoroughly mixed. One duplicate sample was taken from the bulked sample for eelworm counts. Ten such duplicate samples were taken in all.

In the second method, the soil was sampled at twelve points completely at random and then bulked. One duplicate sample was then taken from this bulked sample for eelworm count. As before, ten such duplicate samples were taken in all. The coefficients of variation were 10% for the first method and 13% for the second method.

3.2. *Estimation of starch content in roots of Grevillea Robusta.*

A circle of radius one metre from the trunk was marked out. Five samples of root were taken at points located at random along the circumference of this circle for the determination of starch content. The radius of one metre was chosen as being the most convenient under field conditions.

This method of sampling roots gave a coefficient of variation of about 11%.

The field and laboratory work in connection with the above sampling methods were done by officers of the Nematology and Plant Pathology Divisions respectively.

4. General

The Division continued to give advice on design, analyses and sampling techniques to the Research Divisions.

REPORT OF THE SUPERINTENDENT OF ST COOMBS ESTATE FOR 1963

J. G. G. Tennekoon

Staff

There have been a number of changes in the staff of St Coombs during the course of the year.

The Head Teamaker Mr A. T. Fernando left the estate on 15th June, 1963 after a prolonged illness. Mr G. M. D. Silva took up appointment as Head Teamaker on 1st July, 1963. The Assistant Teamaker Mr W. G. Rajapakse left the estate on 6th June, 1963 to take up an appointment at CeyTea Factory Agrapatna. Mr V. A. Fernandez was appointed as Assistant Teamaker on 1st June, 1963. Mr G. Navaratnam was appointed Junior Assistant Teamaker on 1st March, 1963. This was a new appointment.

Of the Office Staff, Mr G. L. A. Thomas left for St Joachim Estate on 19th January, 1963. He took up appointment as Head Clerk on St Joachim Estate. Mr H. C. Wickremasinghe was appointed Senior Assistant Clerk on 25th March, 1963. Mr V. Kodagoda Clerk/Conductor left to take up appointment as Clerk/Typist in the T.R.I. Office on 31st March, 1963. Mr P. Periyannen has been temporarily appointed to this post.

Acreage as at 31st December, 1963	A.	P.	R.
Tea in bearing	222	0	33
Llan Thomas and 14B area — 1961 planting	8	3	17
Field No. 7 & No. 8 — 1962 planting	10	1	00
Field No. 7 & No. 8 T.R.I. experimental planting	12	1	14
Field No. 2 & No. 7 — 1964 planting (rehabilitation)	15	1	00
Field No. 3 — 1965 planting (rehabilitation)	15	0	00
Area given in exchange for Mattakelle Estate land	1	1	25
Area reserved for Clonal cuttings	2	2	00
Tea seed bearer areas	0	0	09
Nurseries in Field Nos: 1, 12, and 14A	3	0	08
Fuel Clearings etc.	29	1	38
Buildings, roads, gardens etc.	60	3	37
Land unsuitable for planting	40	3	22
	422	1	03

Uprooting a 15 Acre block annually for replanting was stopped this year in accordance with T.R.I. policy. Future uprooting will depend on the demand for experimental planting.

Weather (Estate gauge)

	Rainfall inches	Wet days	Sunshine hours
Registered in 1959 ...	92.80	212	1,996
Registered in 1960 ...	106.48	250	1,686
Registered in 1961 ...	86.56	206	1,382
Registered in 1962 ...	86.01	214	1,710
Registered in 1963 ...	83.50	231	1,440
Decennial averages (1953-1962) ...	88.66	223	1,768

Rainfall recorded during the first three months was 13.32 inches in 36 wet days, as compared with the Decennial Average of 10.48 inches for the same period. Cold nights were experienced during this period but no frost attack was observed.

Rainfall recorded during the period April to July was 30.36 inches as against the Decennial Average of 38.72 inches for the same period. Another mild South West Monsoon was experienced.

In the period August to December 39.82 inches of rain was recorded as compared with a Decennial Average of 40.12 inches for the same period. Heavy rain was experienced in November which carried over into December. These months were wet and cloudy.

The total recorded rainfall for the year was 83.50 inches which was 2.54 inches less than in 1962 and 5.93 inches less than the Decennial Average. There were 231 wet days, 17 days more than in 1962.

Crop

The estimated crop of 300,000 lbs made tea was exceeded by 14,267 lbs and the yield per acre for the year was 1,445 lbs which constitutes a record for St Coombs. The monthly intake of crop throughout the year was as follows:—

Month	Made Tea Lb	Yield per acre
January	23,065	106
February	20,055	92
March	26,648	123
April	29,678	138
May	37,086	171
June	32,531	149
July	24,282	111
August	27,341	124
September	22,973	105
October	21,608	98
November	25,575	117
December	23,428	110
	314,267	1,445

The highest monthly crop was harvested in May when the average yield for the estate was 171 lbs per acre. The yield obtained for June was exceptionally good while October, November and December crops were less than anticipated.

No Sunday plucking and cash plucking was resorted to on any occasion during the year. The quality of leaf brought into the factory was good throughout.

Prices and Total Crop Sold

Year	Total crop sold lb	Gross price cents	Nett price cents
1963	294,101	261	219
1962	285,794	268	223
1961	292,870	268	220

These prices compared favourably with the high-grown average.

	1963 Cost per lb cents	1962 Cost per lb cents	1961 Cost per lb cents
Estimate ...	147.31	156	165
Actual ...	140.63	145	154

Profits on Estate Working

1963	Rs. 222,077
1962	Rs. 233,443
1961	Rs. 220,198

Capital Expenditure

1963 ...	Rs. 40,704.	(12 cts. per lb)
1962 ...	Rs. 130,902.	(43 cts. per lb)
1961 ...	Rs. 82,528.	(28 cts. per lb)

The main items of capital expenditure were:—

Water supply to lines	Rs. 1,974.91
Buildings	Rs. 7,937.69
Replanting	Rs. 30,793.40

New Clearings:

	Spent	Subsidy
1961 planting — 8¾ acres —		
1962 planting — 10 acres —	Rs. 49,717	Rs. 58,395
1963 planting — 15 acres —		
1964 planting — 15 acres —		

Ravines to be cleared	Rs. 888.05
Factory	Rs 933.50
Furniture	Rs. 960.00

Plucking

7-8 day plucking rounds were maintained throughout the year and the standard of leaf harvested was satisfactory. The average per plucker for the year was 34 lb compared with 30 lb in 1962 and 25 lb in 1961. The system of norms is working satisfactorily.

Estate Roads and Paths

Routine maintenance of field roads, footpaths and estate roads was carried out. Terracing of road side drains was done where necessary. Roads and Paths are in order.

Fuel Clearings

Routine maintenance work was carried out during the year. All drains running on either side of St Coombs Street were cleaned and deepened where necessary. Supplies of firewood were adequate and the demands of all estate and institute Staff were met.

Boundaries and Ravines

All boundaries are in order and were regularly cleaned and maintained throughout the year. Regular checks for weeds and cootch were maintained. Ravines in No. 4 Field were cleaned out and planted up with mana grass.

Weeding

The over-all cost of weeding for the year was Rs. 9/17 per acre. A regular monthly round was completed, 154 acres being weeded on contract and the balance on estate account. All weeds were transported away from the field and turned into compost or burnt.

Pests and Diseases

Blister Blight: Regular spraying rounds were carried out during the year, stopping only when favourable weather conditions prevailed. Mist-blowers were used throughout with 4 ounces of Colloidal copper in two gallons of water per acre. This was increased to 6 ounces in all fields recovering from pruning.

Scarlet, Yellow Mite, Tortrix and White Grub: No attacks of any severity were observed during the year.

Poria: Isolated Poria patches in Field Nos: 3 and 5 received special attention during the year.

Loranthus: Loranthus growing on grevilleas have been removed in all fields.

Pruning

The following fields were pruned during the months indicated against each field:—

No. 4	—	30½ acres	...	July-August
No. 9	—	15¾ „	—	August-September
No. 10	—	11 „	...	September-October
		57¼ acres		

A medium prune was carried out leaving all good wood. Tipping was done on the slope and recovery generally was satisfactory. Pruning began on the 1st July and the programme was completed on the 15th October.

Supplying and Nurseries

The programme for supplying was interrupted during the year as a number of plants from cuttings put down in the period July to September 1962 for supplying in 1963 were found to be infested with meadow eelworm.

All plants were destroyed and the entire nursery site was fumigated twice, Guatemala soil for cuttings was collected and fumigated thoroughly.

Till sufficient soil was collected for polythene sleeves, cuttings were struck in callousing beds. Cuttings were put down in June, July and August.

Due to very wet weather prevailing at the time polythene sheets were used over the coir matting to prevent waterlogging in the beds.

The soil mixture used was 4 parts Guatemala soil to 1 part tea fluff and 1 part of sand. Woven coir matting was used for shade.

T. 65 manure was applied 1 at oz/gal/sq yd/fortnight, and was watered on.

The following quantities of plants are available for 1964 supplying:

Clone	No.	No. of Plants
TRI	2026	5,970
,,	2142	10,014
,,	2043	6,050
DT	1	5,420
TRI	2023	21,640
,,	2025	7,000
,,	2024	7,659
,,	777	15,878
DT	95	1,827
E	727	3,838
TRI	26	3,000
,,	740	500
,,	2016	500
,,	2039	500
W	3	500
TRI	2027	500
,,	25	500
MG	—	500
N	—	500
Seedlings		5,925
	Total ...	98,221

Mossing and Ferning

Pruned fields were treated with "Limbux" to control moss and lichen at 1½ cwt per acre, using Birchmeir Senior Sprayers with No. 2 lime-washing jets.

Manuring

In keeping with the T.R.I. policy of the previous year when increased doses of manure were given, an average of 180 lbs of Nitrogen per acre per annum was applied in 1963.

In 1964 manure is being applied according to the new T.R.I. recommendations (T.Q., Vol. 34, Part 3, Suggested schemes for level of manuring of mature tea).

Manure was broadcast in both rows and the number of applications averaged four per field.

All fields pruned during the year received one application of dolomite at a rate of 400 lbs per acre which was broadcast in both rows.

Zinc Sulphate was applied in the form of a foliar spray on mature tea in bearing at 4-6 ozs in 2 gallons of water per acre together with copper fungicide in mistblowers. An average of 12 lbs per acre was applied for the year.

Green Manure and Shade Trees

Low shade consisting mainly of dadaps and some Acacia pruinosa was lopped twice during the year and is well regulated.

Dadaps were resupplied in two pruned fields No. 4 and No. 9 where the dadap rows stood eight tea rows apart.

Cootch and Illuk

Isolated patches of Cootch grass and Illuk in all mature tea areas received attention during the year and are under control.

New Clearings

1960 *Clonal Planting — Blocks:* 8A and 8B — 2 Acres — Planted June 1960 These areas are receiving routine treatment.

1961 *Clonal Planting — Llan Thomas area* 4 *Acres and 14B area* 4¾ *Acres:*

Routine weeding and spraying was done Manuring was done 6 times during the year using the T.200 mixture at 1 oz. per plant per application. Drains were cleaned out, Dadaps were lopped twice during the year and Boundaries and Ravines attended to. These clearings were plucked lightly in January and February. In April it was plucked on a 7 day round and this continued to the end of the year. Llan Thomas area (Clone 2024) yielded 2,078 lbs per acre to the end of the year. 14B area (Clone 777) yielded 1,164 lbs per acre to the end of the year.

These areas will be brought into Revenue A/c in 1964.

1962 *Clonal Planting — Field No.* 7-6 *Acres No.* 8-4 *Acres:*

Routine weeding and spraying was done. Manuring was done 6 times during the year, using the T200 mixture at ¾ oz per plant per application, Drains were cleaned and dadaps were lopped twice. Plants were centered once and thumb nail pruned twice later.

The growth in some areas of the clearing has been poor. Plants were examined regularly and it was found that the non-removal of the entire polythene sleeve had restricted root growth. This clearing was planted out for observation with plants in polythene sleeves, where the lower half of the bag was supposed to have been removed at the time of planting. Since root growth was being restricted, the balance sleeves were removed fully in the wet weather in October and hardly any casualties have been observed subsequently.

Areas under Rehabilitation for replanting. 1964 *Replanting* — 15 *Acres* (*Field No.* 2-7½ *Acres No.* 7-7½ *Acres*), Gautemala was cut at ground level in January. Since replanting this clearing was deferred till 1964, one half of the area was replanted with Guatemala and the other half was planted in Marigold.

1965 *Replanting* — 15 *Acres Field No.* 3.

Guatemala was lopped three times during the year at 14 inches above ground level. The area was manured after each cut at 4 cwt. grass manure per acre, per application, the manure being broadcast.

1965 *Replanting* — 17¼ *Acres in Field No.* 3.

Uprooting this area has been deferred in keeping with T.R.I. policy. Only areas required for experiments will be uprooted in future.

Factory and Machinery

Messrs H. W. Hammond & Co., made their annual inspection on the 23rd May, 1963 and the recommendations contained in their report are being carried out. Repairs were done on Roller No. 2 and Roller No. 4 and the Leaf Hoist.

Manufacture

Manufacture during the year was carried out mainly with a 4 roll programme as folllws: *i.e.*, 4 rolls of 30 min duration (120 min rolling) Four periods of roll-breaking of 10 min. duration (40 min. roll-breaking) with 2½-3½ hours fermentation, charges every 50 min. Order of firing 2, 1, 3, 4 big bulk.

The percentage of dhools obtained from the above programme were as follows:

1st Dhool	...	15%
2nd Dhool	...	22%
3rd Dhool	...	30%
4th Dhool	...	23%
Big Bulk	...	7%
Evaporation	...	3%
		100

Grade Percentages

	1963	1962
Broken Orange Pekoe	70.40	70.73
B.O.P. Fannings	13.87	8.87
Flowery Pekoe	—	2.01
Fannings	1.72	6.00
Broken Pekoe	2.02	1.63
Broken Mixed ...	5.45	5.53
Dust – 1	5.18	4.83
Dust – 2	.80	—
Experimental Teas ...	.56	.40
	100.00%	100.00%

Out-turn of made tea to green Leaf	22.43%	23.40%

Rotovane Manufacture

Experiments on the Rotovane have gone on through the year. In the period June to December approximately 20% of all tea manufactured consisted of Rotovane tea.

Factory Extensions

This building has been completed and three withering machines are being housed in it.

The Trough Withering machine has already been installed and preliminary experiments have been done.

The Drum Withering Machine and the Japanese Withering Machine have not been worked yet due to shortage of power.

Labour

36 children over the age of 14 years were registered during the year. Together with 9 incoming brides the total number registered was 45. One family consisting of three workers and two children retired to India. Health was generally good.

The labour force co-operated reasonably well with the management throughout the year.

	Men	Women	Non-working children	Total
Working labourers on estate as at 31st December, 1963	254	249	—	503
Non-working labourers (Pensioners) ...	26	29	—	55
Non-working children	—	—	590	590
Total estate population ...	280	278	590	1148

Working labourers numbered 1.74 per cultivated acre and the percentage of out-turn was 91%. 28.05% of all labour employed was used by the Institute for experimental work.

Buildings and Lines

The total number of units, all up to Government standard, is 40 sets or 254 rooms. The number of workers per room is 1.98 and the number of souls per room is 4.28.

During the year white-washing was done and all necessary minor repairs completed.

A further set of lines, P.A. Health Scheme Plan No. E/LQ/7 (A) cottage type was completed. One Cattle Shed in the lower colony was re-roofed. A new water pump with A.C. Motor was installed for supply of water to all lines below Superintendents Bungalow.

All minor buildings on the estate are in satisfactory condition.

Visiting Agent

Mr. Alexander Mackie visited the estate on the 8th April, 1963. Mr J. Nelson Parker visited on the 24th June, 1963. Mr P. R. U. Easteal visited on the 20th December, 1963.

Clonal Blocks

During the year 1,745,720 cuttings were sold to estates all over the Island. It is hoped that other estates will endeavour to meet the demand of the more popular clones in the near future.

General

The year under review has been a satisfactory one. The yield of 1,445 lb per acre being the best to-date.

We look forward to a good season in 1964.

REPORT OF SUPERINTENDENT OF ST JOACHIM ESTATE FOR 1963

C. Andrews

Staff

Mr C. Andrews was appointed Superintendent and assumed duties on the 7th of January.

Mr R. J. S. Bean who was Visiting Agent resigned during the latter part of 1963 and Mr J. W. Craig was appointed in his place and visited the property once in October, 1963.

The Clerical staff consists of one Head Clerk and two assistants. The Head Clerk was recruited from St. Coombs and one of the assistants from Palmgarden Group.

Acreage

	A.	R.	P.
Tea in full bearing	286	1	38
T.R.I. Experimental	9	0	00
Tea Nurseries	1	3	11
Rubber	20	0	00
Paddy lands	29	1	24
Buildings & Premises	46	1	25
Other cultivations-Labrs' gardens ...	3	1	22
Roads	13	2	10
Areas not in possession-encroachments	0	2	00
Shrubs, deniyas and bareland ...	5	2	16
	416	0	26

Approximately 9 acres of very old tea in field No. 3 was uprooted and planted up in Gautamala. Another ½ acre was uprooted and replanted immediately with 2023 cuttings by the T.R.I.

Weather

Comparative figures of rainfall are given below. Generally, the weather was wet compared to 1962 and total rainfall was 134.79".

The total for the year was 174.22" but annual amounts of over 180" have been recorded previously.

Distribution of rainfall was fairly even.

Although temperatures were not recorded, they appeared to be somewhat lower than those normal to the district, no doubt a result of the well distributed rainfall.

Winds were mostly southerly or south-westerly. There were a few gales of perhaps 40-50 knots which however did not cause much damage.

A feature which may be of passing interest is the frequency with which certain areas are struck by lightning.

There was heavy mist in November and December often lasting till about 9·00 a.m.

Crop	1963		1962	
	Made tea	Green leaf	Made tea	Green leaf
Estimated	302,000 lb	1,313,000 lb	—	—
Secured	339,932 lb	1,725,986 lb	287,264 lb	1,423,178 lb.
Yield per acre	1,174 lb		881 lb	

Monthly figures are as follows:

	Made tea	Yield per acre
January	23,901 lb	99 lb
February	26,890 ,,	91 ,,
March	32,823 ,,	111 ,,
April	33,647 ,,	114 ,,
May	27,529 ,,	96 ,,
June	26,437 ,,	92 ,,
July	28,966 ,,	102 ,,
August	25,853 ,,	90 ,,
September	26,992 ,,	94 ,,
October	26,151 ,,	92 ,,
November	28,098 ,,	98 ,,
December	27,245 ,,	95 ,,

Sale of Green leaf.—Green leaf was sold to Palmgarden group factory and the poor prices realized for low-country teas was reflected in the prices paid to us which to end of December was 19.84 cents.

With these prices the estate could naturally not work at a profit, but the yield of 1,174 lb per acre obtained offset what would otherwise have been a much greater loss.

Capital expenditure.—15 sets of double unit quarters were nearing completion at the end of the year.

These were erected to accommodate additional labour and also to ease the problem of over-crowding in the existing lines.

Factory.—The area for the factory was levelled out to a prescribed contour, but the actual erection of the factory had not commenced at the end of December. Some preliminary structural work was done at Messrs Walkers Limited, Colombo who were given the contract for erection of the factory, which is scheduled to be completed in eight months time from the date of handing over the site (which was on 1st December, 1963).

The factory is estimated to cost Rs. 800,000 and eventually to have a capacity of 1,000,000 lb made tea. It will of course have the most modern equipment and will be a definite asset to the Low-country.

Cultivation

Plucking—There was a shortage of labour at the beginning of the year and plucking rounds could not be maintained at a regular interval. This situation was remedied later and rounds kept at an average of 7days.

The plucking average was 41 lb.

Weeding.—With the shortage of labour and prevalent wet weather monthly weeding rounds could not be maintained. This was a problem affecting the whole district.

Weedicides were introduced, and though quite successful in eliminating weeds, certain adverse effects on the tea and gliricidias were observed. More experiments in the actual intensity of weedicide and frequency of application are in progress.

Where shortage of labour is a problem weedicides appear to be indicated, but will have to be used with caution.

Pests and Diseases —Pests and diseases have been at a minimum. The late November and December mists brought on a mild attack of blister blight but this was soon brought under control by lopping and short rounds and without the use of fungicides.

There were isolated deaths of V.P. bushes but the cause of death in most cases could not be ascertained with any certainty. Laboratory tests of some bushes revealed lack of starch.

A fungus discovered mostly after pruning was horse-hair blight and this was fairly heavy in certain fields.

Pruning.—138¼ acres were completed as scheduled.

Supplying.—A total of 113¾ acres was completed. Infilling has been a great sucess here and the intensive infilling done by Mr Ross is already reaping befits in increased yields.

Manuring.—T.521 was applied throughout the year with Nitrogen at 123 lb per acre.

One forking was done after pruning and broadcasting done thereafter.

Shade and Green manure trees.—These were lopped whenever necessary.

1964 *New planting.*—15 acres of the old seedling rubber areas were uprooted for supplying with various clones in 1964. A new road linking this area with the rest of the estate was completed early in the year.

Cart roads.—The main Hidellana/Karapincha road is maintained by the estate. The funds of approximately Rs. 1,174/- per annum granted us by the P.W.D. is insufficent for even routine maintenance. The road is narrow and unsuitable for heavy traffic. There are frequent break-downs of culverts which were designed for bullock carts and light traffic of several decades ago. Extensive repairs, particularly to culverts, are a necessity.

Medical.—The estate continues to pay an amont of Rs. 7,000/- per annum for medical facilities and although this is not the most desirable arrangement we are, in the circumstances, indebted to Palmgarden for offering these facilities.

Transport.—The estate maintains a lorry and all transport is done by this.

General remarks.—We are indeed greatly indebted to the Manager of Palmgarden group and Messrs George Steuart and Co. for their co-operation, and we trust these cordial relationships will continue.

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METEOROLOGICAL OBSERVATIONS — 1963
ST. COOMBS

Laboratory Gauges

MONTH	TEMPERATURE °F						Mean Relative Humidity	RAINFALL		RAINY DAYS		SUNSHINE	
	Mean Maximum	Difference from Average (25 Years)	Mean Minimum	Difference from Average (25 Years)	Adopted Mean	Mean on Grass		Inches	Difference from Average (25 Years)	Days	Difference from Average (25 Years)	Hours	Difference from Average (25 Years)
January	72.3	+ 1.8	54.7	— 1.0	63.5	53.2	66	3.85	+ 0.25	12	+ 1	170.36	— 22.34
February	74.5	— 1.8	52.5	— 2.1	63.0	48.2	69	2.49	+ 0.14	8	0	205.33	— 5.35
March	75.5	— 2.2	54.3	— 1.2	64.9	50.2	62	4.65	+ 0.11	8	— 4	197.70	— 36.31
April	76.1	— 1.3	56.1	— 1.7	66.1	52.9	64	7.08	+ 0.71	15	— 1	201.10	+ 4.66
May	76.1	+ 3.7	56.6	— 3.1	66.3	54.9	70	5.13	— 6.15	17	— 1	187.40	+ 23.40
June	74.9	+ 4.3	55.7	— 4.7	65.3	54.0	69	8.71	— 4.39	14	—12	153.50	+ 61.46
July	72.9	+ 2.7	57.6	— 1.9	65.2	54.7	77	7.34	— 4.40	21	— 5	88.70	— 16.49
August	72.3	+ 1.3	57.4	— 2.2	64.8	55.5	77	6.08	— 3.34	19	— 6	116.71	+ 2.55
September	71.3	— 0.9	58.2	0	64.7	57.5	77	8.63	+ 0.31	18	— 3	115.26	— 25.06
October	72.9	— 0.2	56.7	— 1.0	64.8	54.8	77	8.33	— 1.36	19	— 3	122.00	— 27.36
November	72.0	— 1.5	57.9	+ 0.8	64.9	56.2	84	8.97	+ 1.55	22	+ 3	112.40	— 49.12
December	71.5	— 2.0	56.7	+ 0.6	64.1	54.5	85	6.46	+ 1.24	17	+ 2	147.10	— 22.13
	73.5	+0.22	56.2	— 1.4	64.8	53.8	73.1	77.85	—15.63	190	—29	1817.56	—112.09
	Means							Totals					

The Tea Research Institute of Ceylon

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The Tea Research Institute of Ceylon

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*Working overseas